August 1992 • £1.50

NEW PRACTICAL ELECTRONICS

SCIENCE AND TECHNOLOGY

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HiFi On The Road

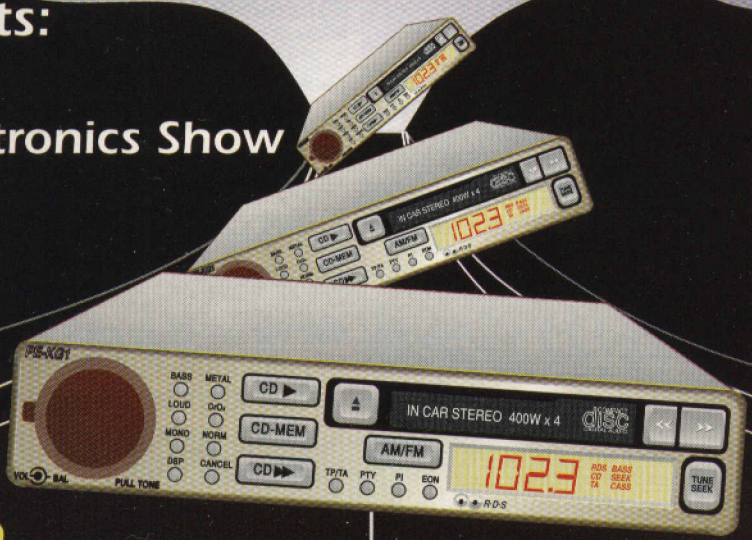
We take a look at in-car stereo systems

We are giving away 50 Sony UX Turbo Cassettes

Is This The Future Of The Personal Organiser?

Plus

Special Reports:
Multimedia 92
Consumer Electronics Show



Opinion

Barry Fox On Illegal Gadgets
Ian Burley On Multimedia

0 9 770032 637017

This month...

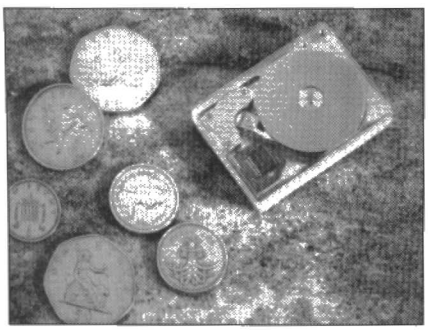
A slight change to the magazine this month as we take a stand with our new opinion pages. Industry pundits Barry Fox and Ian Burley make their views known on the subjects of advertising and multimedia.

Multimedia also features in one of our show reports as does the bi-annual US consumer electronics show. All of the electronics hardware that you can expect to appear in the shops was on display. In fact, there was so much of it, we've had to split our report in two.

I hope you fill in the reader survey on page 44 so that we can keep abreast of what it is you like (or possibly dislike) about the magazine. You may even get lucky and win one of Sony's special new cassettes.

Kenn Garroch, Editor

Electric cars on parade – page 10



A 20M hard disk in a matchbox – page 18

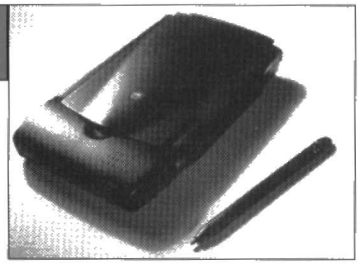
Next month...

Photography
Electronics in cameras and image storage plus CES part 2.

Out On 6 August

Cover illustration and design: Kenn Garroch (with inspiration from Steven Spielberg)

Features



The Apple Newton – page 13

Sony's new tape – page 26

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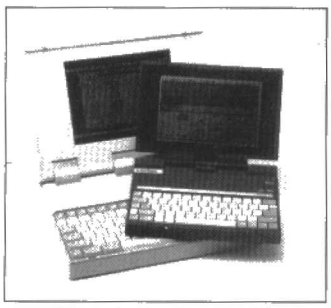
DCC for sale – page 14



A5 portables – page 20

Editor: Kenn Garroch Advertisement Manager David Bonner Accounts Manager Martin Milner Production Manager: Richard Milner Additional photography by Carolyn Vaughn Publisher: Angelo Zgorelec • **Practical Electronics Intra House 193 Uxbridge Road London W12 9RA Tel: 081-743 8888 Fax: 081-743 3062 Telecom Gold: 87: SQQ567 CIX Care of PROGNOW • Advertisements** The Publishers of PE take reasonable precautions to ensure that advertisements published in the magazine are genuine, but cannot take any responsibility in respect of statements or claims made by advertisers. The Publishers also cannot accept any liability in respect of goods not being delivered or not working properly. • Practical Electronics is typeset and reproduced at Intra Press on Macintosh computers using Quark Xpress, Scan Xpert scanner and Adobe Photoshop. Advertising reproduction by Circle Rule Ltd. Printing by Andover Press, St Ives plc. Distribution by Seymour Press • **ISSN 0032-6372** •

Wavelengths

If you have any comments, suggestions, subjects you think should be aired, write to PE

Vista Address

Your review of the Vistapro virtual reality program in Practical Electronics June 92 was very interesting. The only thing missing was the name of a supplier. The comment "Vistapro is available from all good software suppliers" is of no help at all. Can you name your source?

P Wills
Northampton

The package is actually produced by a US company called Virtual Realiy Laboratories Inc but a UK distributer is PCConnections Tel 0706 222988

It may also interest you to know that a new version of Vistapro will soo be available with improved flying sequences and the VR Labs are hoping to get hold of the Magellan radar data from NASA to produce maps of the surface of Venus.

Photo-Video

I read with interest your features on Kodak's Photo-CD and would like to add a few comments. Firstly, I think that it is quite a nice idea but rather expensive and secondly, I can think of a cheaper and far more efficient way of doing the same thing.

Since the quality of the screen image is limited by the resolution of the TV, the best quality result can never be better than that of the TV screen. What I suggest is to use a video recorder and a camcorder. Photographs taken with the camcorder lasting up to 30 seconds can be stored in sequence on the video recorder. By using the still frame feature of the VCR, up to 1080 pictures can be stored on a 180 minute cassette tape if each is there for only 10 seconds. I would think that this is easily long enough to fast forward and freeze frame on the desired image.

A though that occurs at this point is that the above technique has been possible for the past couple of years and since I have not seen it mentioned elsewhere, there are only three reasons why it is not used. It doesn't work, nobody has though of it before or nobody wants to bother. The last possibility seems the most likely but it could be rather upsetting for Kodak who has spent umpteen thousands of pounds developing its Photo-CD system.

A Harshaw
Birmingham

Equipment Needed

The meteor scatter feature in the June issue of Practical Electronics was most interesting. Could you possibly tell me of any manufacturer of equipment that actually enables me to use this technique to send and receive information?

M Shannon
Swansea

I'm afraid that no one here at PE knows of a suitable company. Perhaps our readers can help?

Wanted: A cable

Why is it taking cable TV so long to be installed throughout the UK? I am very keen to get my hands on it. Apparently you can get all the satellite channels and other services such as phones, and there is no interference. I thought that the cables could be laid in existing gas or water pipes by little robots.

Henry Latham
Hayes
Middlesex

The trouble, as usual, appears to be a lack of cash. The cost of installing cable is quite high as roads have to be dug up to run it past houses. Until these houses take up the option of using cable and it becomes a viable alternative to broadcast and satellite TV in the eyes of the public, the costs will remain quite high. Hopefully, within five to ten years, cable will take over completely.

Mosquito Killer

I have noticed a lot of high street chemists selling battery powered electronic mosquito killer devices. Can PE confirm if these gadgets actually work? And if they do, how do they operate. I would be interested to know because I am going on holiday to the Isle of Skye this year and have heard the midges there are terrible.

Congratulations on the new look of the magazine.

Toby Lynch
Streatham.

PS How about a mosquito killer project?

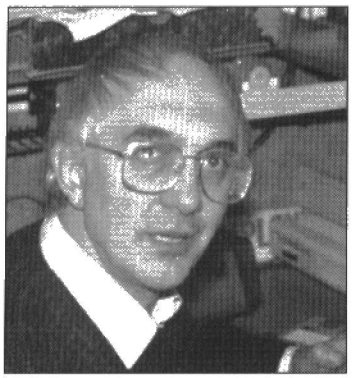
As far as we are aware mechanical mosquito killers are quite useless. The best deterrents are vapour blocks that are evaporated in special heaters or good smelly mosquito repellents.

On-line Service

I am thinking of getting a modem for my Atari ST, so I can access on-line services like CompuServe. Please can you explain the various different baud rates and protocols. Is it worth my while buying a 9600 baud unit? – these are about £600 each, which is more than I really want to spend.

Peter Zamit
Manchester

Taking the time savings due to the higher speed and the saving in telephone bills into account, a 9600 baud modem is generally worth the extra cost – it will probably pay for itself in the long run. Take a look at our feature on page 30 for more details. ■



Barry Fox

Is it right to advertise something that doesn't work?

Magazines continually face a tricky dilemma. Should the advertising and editorial staff cooperate or work completely separately?

It is a no-win situation.

A science magazine campaigned against scaremongering advertisements for computer screen shields. The adverts played on the fears of pregnant women by suggesting that radiation from computers could harm unborn children. Because the magazine had a policy of independence, with no collusion between advertising and editorial staff, the magazine ran the scaremongering advert. Readers must have wondered what on earth was happening.

But readers will not trust a magazine if advertisements puffing a product "just happen" to appear on the next page from an article praising the product. This can happen if a journalist writes independent comment on a product which happens to be favourable, and the advertising staff see it the text in advance and use it as an opportunity to sell space for an advert.

As Practical Electronics has carried advertisements for a piece of equipment which is likely to make bad news, here is some independent comment and news, after the event.

"Slash your phone bills!!! 100% free dialling!!!" promises the advertiser, Top Secret Electronics of Malton in Yorkshire. "After months of legal battles we can now offer you the Creditcall from the inventors of the original Black Box".

The Black Box was a gadget developed by electronics buffs, known as "phone phreaks", twenty years ago in the US. It fooled the telephone system into giving subscribers free calls, by bleeping access codes into the handset.

"Simply plug the remarkable Creditcall into any authorised socket, then plug your telephone into the Creditcall. It works by blocking the metering pluses on the line and suppressing the charge signals" explains the advert. "Beware of inferior copies being sold in London for well over £200 – save a fortune for just £34.95 plus £2.50 postage and packing".

All these gadgets look like a modified two-way telephone adaptor (which lets two phones plug into one standard BT socket) and have a light emitting diode which glows red or green when the line is in use.

"These devices are completely, utterly useless" says BT. "They do not affect call metering in any way".

But subscribers who use them see the light glowing and make long distance calls round the world, thinking they will be free. Later they get the bill and discover they were not.

The subscriber cannot then complain to BT about the call charges because that would give BT the opportunity to prosecute on the two counts routinely used against anyone caught trying to get free calls, attempting to defraud BT and illegally using BT's electricity. The complainant would also be in trouble from admitting the use of a telephone accessory not certified by the British Approvals Board for Telecommunications.

The purchaser also cannot complain to the advertiser. Very small print at the end of the Top Secret advert warns that connection of the device is "strictly prohibited", that it must not be used "without the full consent of the telecommunications system provider" and that "the unauthorised obtaining of free telephone calls is a criminal offence".

Buried even further in the small print is a promise that money will be returned if purchasers are not "entirely delighted". The twist here is that the no-quibble, money-back guarantee carries the proviso that the gadget must be returned in "received condition". BT's engineers found that the gadget could only be used after a tag had been broken off.

Anyone applying to buy the gadget also has to sign a written declaration that they are "purchasing this unit as novelty only" and will not connect it to a telephone.

BT can recall only one previous case of comparable cheek. An entrepreneur offered subscribers a service called "Billbusters", for £7.50. It promised an end to all BT's telephone bills. Those who paid got back a letter telling them to cancel their account with BT. They would then get no more telephone bills.

Creditcall was also advertised by leaflet with local newspapers in York and Scarborough. This lead the North Yorkshire Trading Standards Officers to investigate, and see whether the adverts contravene the Trade Descriptions Acts and warrant prosecution. Other TSO's round UK are investigating other, similar, devices.

The TSO's have been working with a report produced by BT who X-rayed a Creditcall to see what was inside. BT's X-rays showed a 330Ω resistor in series with a diode (probably type 1N4001 with probable peak inverse voltage rating of around 100 volts), a capacitor of around 1µF value, and standard green LED. The LED lights only if the exchange line has incorrect polarity and the receiver is off the hook. Reverse polarity, does not necessarily cause a telephone to mis-operate.

BT's technical expert tested the device on a number of different exchange lines and found no effect on metering pulses and no effect on metered charges, either on incoming or outgoing calls.

I phoned Top Secret Electronics who insisted that that the device worked, and sent me explanatory notes. These claimed that the device blocks metering by converting BT's AC metering pulses into DC pulses. Perhaps significantly, the notes are marked "E&OE" at the bottom. They also confirm that the device is sold with a sticker tag which must be removed to use the device, and removal invalidates the guarantee.

At around the same time, the national press reported that two people in Wales had been jailed for up to eight months, and fined £6000, with costs. After just three weeks in business three hundred people had paid them £32,000 for meter-fooling sockets which did not work. The judge said that those who had bought the devices were "greedy and unprincipled, and no-one who had been fooled should be eligible for compensation".

So you have been warned. If something seems too good to be true, it probably is. There is no such thing as a free lunch. And always read the small print. ■

Ian Burley

Multimedia in no longer tomorrow's technology

I recently attended a multimedia exhibition, Multimedia '92 at Olympia, and was left with the dull realisation that the technology on show there really was going to revolutionise the way we all soak up information. I like to think I knew this was going to be the case all along, but for the first time I didn't have to imagine it. The products were there and prompting people in the industry to ask themselves how multimedia will impact on our everyday lives.

To me multimedia was, among other things, a loose collection of interesting infant CD ROM or laserdisc technologies you could hook onto your PC and amaze your friends with. You went to see multimedia at special sections of PC shows and it was fun to look at but the thought of spending some hard cash on multimedia hardware never entered one's mind.

It was tomorrow's technology.

However, this show was different; this was a show where multimedia itself dominated, not the PCs or peripheral hardware or the media formats, but the purpose and utility of the technology itself. Multimedia is no longer just a curiosity, an accessory or a fascinating hint at tomorrow's computing applications.

The emerging impact of multimedia even moved a group of information technology journalists to meet in a back room at the show to ask themselves the sobering question, does multimedia technology threaten the written word?

Multimedia is a modern day cliche, but what does it mean? The term multimedia – as has been oft-repeated – is many things to many people. For the sake of argument I define it as the ability to access large quantities of multi-format information interactively. By multi-format I mean pictures, sound, text and even motion video. Virtual reality would qualify under my definition and why not? There have been experiments with virtual reality garments like gloves which convey sensory touch. Nobody has cracked the olfactory senses yet, but I'm sure they're working on it. But I digress.

As for 'interactive' the gathered IT hacks spent a good deal of time debating what that term meant precisely, but for me it means having a degree of control over the flow of information you have access to, enabling one's responses to that information to dictate the process dynamically. This is what makes multimedia different to, say, television. TV has text, audio, pictures and motion video but it's unidirectional and certainly not interactive. But with the spread of modern interactive cable TV, multimedia will be piped straight into the home. Multimedia TV could offer real-time voting, instant selection of movies, interactive access to centralised multimedia libraries and more.

The most advanced form of multimedia I have experienced so far was a Northern Telecom telephone services demonstration. You could select which demonstration you wanted by choosing options on a touch screen monitor. One of these involved a demonstration of something similar to BT's Star Services. A video of a woman appears on the screen and she explains what is about to happen. A phone by the workstation rings, the same woman is now talking to you on the phone and she's telling you to push * and # buttons on the hand set and responding accordingly. It was surreal.

Another example is the Pandora multimedia communications project being developed jointly by Olivetti Research and the Cambridge Computer Laboratory. Pandora is an experimental video phone system using powerful workstation computers hooked into a very fast data network. You can record audio/visual messages for later viewing and editing, have one-to-one video phone conversations or conferences. You can also tune into broadcast TV, video or a CD-player, with full control over channels, track selection, stop, pause, etc. It would be a relatively trivial task to attach all sorts of multimedia information bases to Pandora.

The thrust of today's multimedia products lies in standards like CD ROM, CD-I, CDTV, Interactive Video and so on. CD ROM means at least 650 megabytes of data on a single 12cm disc. CD ROM versions of encyclopædias and other books one can loosely describe as 'educational' are obvious candidates for the multimeia CD formats. Not only can you read the text and enjoy the pictures and diagrams you would normally find in conventional books, but you can hear things and and watch them moving too. As one father who happens to be a director of a firm which makes multimedia add-ons for PCs said, multimedia technology is riveting for his kids. But so is TV – the difference is that the kids usually watch TV in a semi-stupor. Multimedia is a stimulating and educational but just as entertaining as TV.

Most important of all multimedia provides you with control You can go back and repeat an animation sequence, the software may even be able to show the effect of some operation you can control, like the Time Life Photography CD-I disc which can show the effects of over and under exposure on a picture as you 'change' the camera settings, for example.

Instruction manuals for complex products like business software packages are now appearing in multimedia form. There's nothing more daunting than a six inch thick wad of books alongside a dozen floppy disks which need individual installation on your PC. A single CD ROM can replace all of this and by providing an interactive version of the manual on the disc a user can become proficient in his or her new software package far more quickly than before.

Given time, multimedia technology will evolve to provide us with gadgets which today's efforts can only hint at. Conventional books will seem quaint artefacts of yesterday's culture; cheap yet limited and even boring. We will be creating our own multimedia, not just buying it. Today's trends towards computer presentation graphics is just a start. Reports, letters and even childrens' scrapbooks could be ordered multimedia compilations.

The multimedia industry will remain confused for quite a while yet as different formats vie for superiority and the technology develops, but there's no looking back now. ■

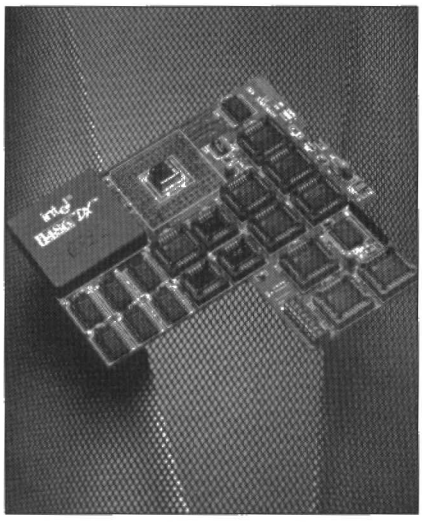
Practical Computing

News from Anthony Robertson

Traditionally the Summer months are quiet ones for computer specific announcements. Times are changing though, the world recession has brought many computer companies to heel. Now it seems, manufactures no longer wait for computer shows to come around in order to launch new products.

Hypertec is one such company who have recently launched a booster card for IBM PS/2 users. A worthwhile power boost will prepare 80386DX based machines for a new generation of demanding software. Production versions of the new Hyperace 80486DX/33 upgrade board, can boost processing speeds by a factor of five!

In use, the unit simply plugs into the existing 80386DX processor socket of PS/2 models 70 and 80. Processor replacement is actually preferable to adding a numerical co-processor to existing installations — the traditional numerical coprocessor route to increased processing speed is limited by the application in use. Replacing the 80386DX micro processor with the Hyperace 80486 based unit running at 33Mhz makes a lot more sense as the power boost will increase the performance of every software package run. This booster retails at £899. Further information can be obtained from Colin Lillywhite, Hypertec Europe Limited, on 0672-63936.



Upgrade from 80386DX to 80486DX painlessly

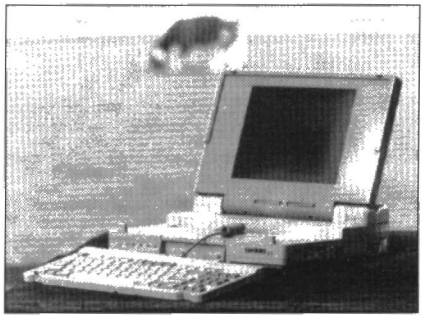
Dual Computer?

When is a laptop not a laptop? When its a desktop of course! Now before you think this columnist is going mad, let him tell you about the Cordata SX.

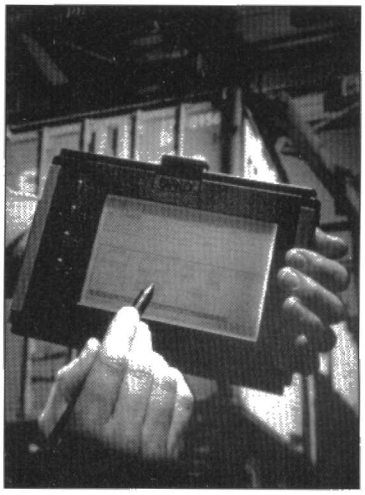
Many desktop owners shy away from laptop computers because of the obvious lack of expansion. If only a Laptop could remain portable and powerful for travel purposes, yet possess the facility for expansion to full desk top specifications. A pipe dream? No a reality with Cordata Technologies of Compton, California.

The Cordata SX offers the best of both worlds being a powerful 16 Mhz 80386SX portable on one hand. Yet able to integrate with a docking station to become a desktop equipped with plenty of space for expansion and additional storage.

Complete with a VGA LCD Screen and Super VGA graphics card, a full AT keyboard complete with detachable numeric key pad, 1Mb RAM plus 40Mb hard drive, and a 1.44Mb floppy. The Cordata SX costing £790 (exclusive of VAT) is now available in Great Britain, from UK Home Computers of Swindon, Tel: 0793-695034.



Two for the price of one?



GRiD's PalmPAD wearable PC

Logitech Deal

Logitech has announced a deal with GRiD systems Corporation, a leading player in the pen-based computer market. GRiD has purchased a digitising tablet and wireless pen from Logitech to incorporate in the GRiD PalmPAD, billed as the world's first wearable PC.

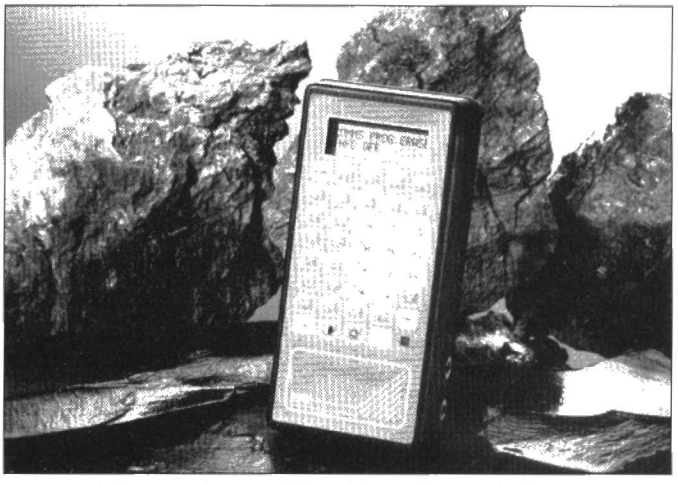
The PalmPAD can be used in the hand or worn on the wrist. It can also be attached to the belt or carried on the shoulder in a durable case and is capable of withstanding three foot drops. For more information please contact Logitech on 0344-891313.

Datac's Award

Datac's new keypad for its DC Series hand-held computers has won a design award sponsored by the Membrane Switch Manufacturers Association. The keypad was entered by its manufacturers, Danielson Limited.

The Datac DC Series is specifically designed to perform data acquisition, storage and transmission in harsh environments, and the larger keys make it easier to operate with cold fingers or when wearing gloves. The 36 key alpha-numeric multi-function membrane has auto repeat, audio click and tactile mobile feedback, and custom designed options are available.

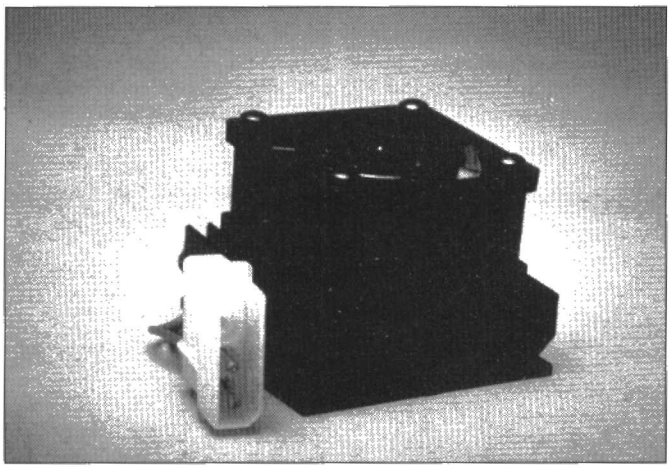
The DC Series comprises four models of hand-held computer, with two-or four line display with optional back-lighting and a wide range of memory sizes. For more information please contact Datac on: 061-941-2361. ■



Pic 4 - caption could be - Dacom's award winner

Innovations

A roundup of the latest happenings in the wide world of electronics, science and technology.



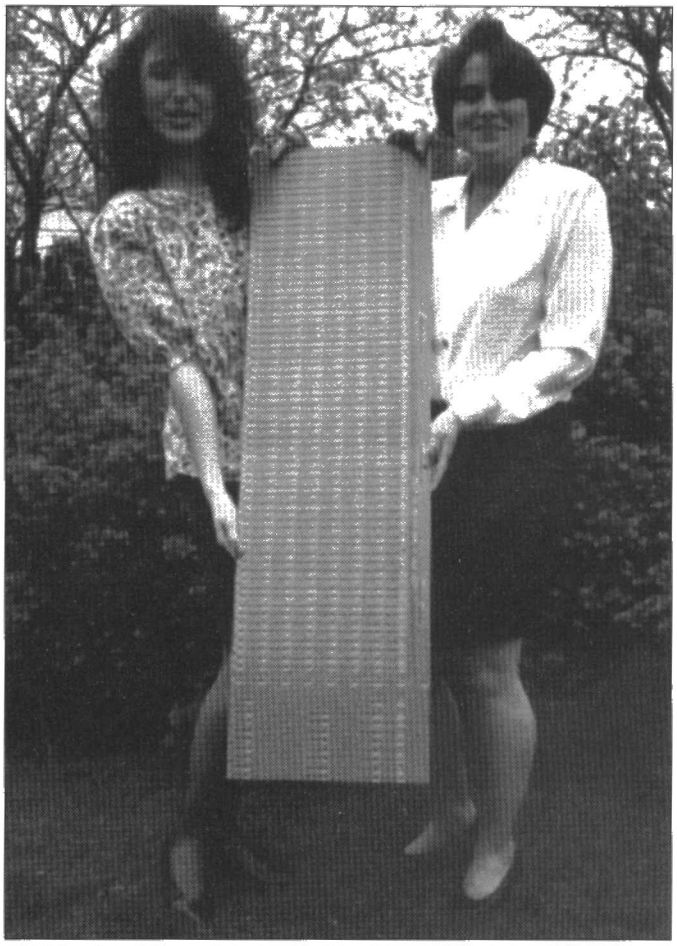
Keeping Kool

Installing an Intel 80486 microprocessor in a computer is not as simple a task as it might seem. Because of the chip's high speed, especially the 486-33 and the new DX2s, it is able to generate a lot of heat – a surface temperature of 76.8C was measured on one 486-33 after an hour of operation. Unless special precautions are taken the life of the processor can be reduced and the machine will throw up inexplicable errors and even crash unexpectedly.

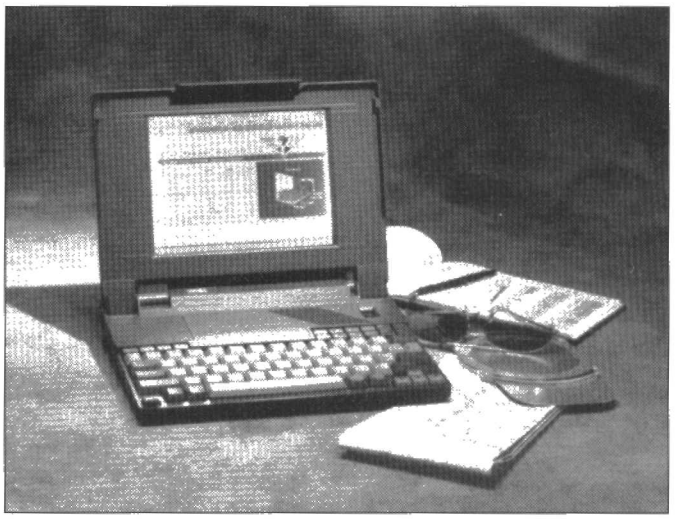
The solution is to put in a more effective cooling system such as CPU Kooler from PCubid Computer Technology which keeps the surface temperature of the chip only 5.6C above the ambient temperature inside the computer's case. The device attaches to the top of the microprocessor and consists of a small fan and a finned heatsink. Power for the 12V motor is derived from a spare floppy disk drive connector available in most PCs. Alternatively, a 5V version is available for direct connection to the main board power supply.

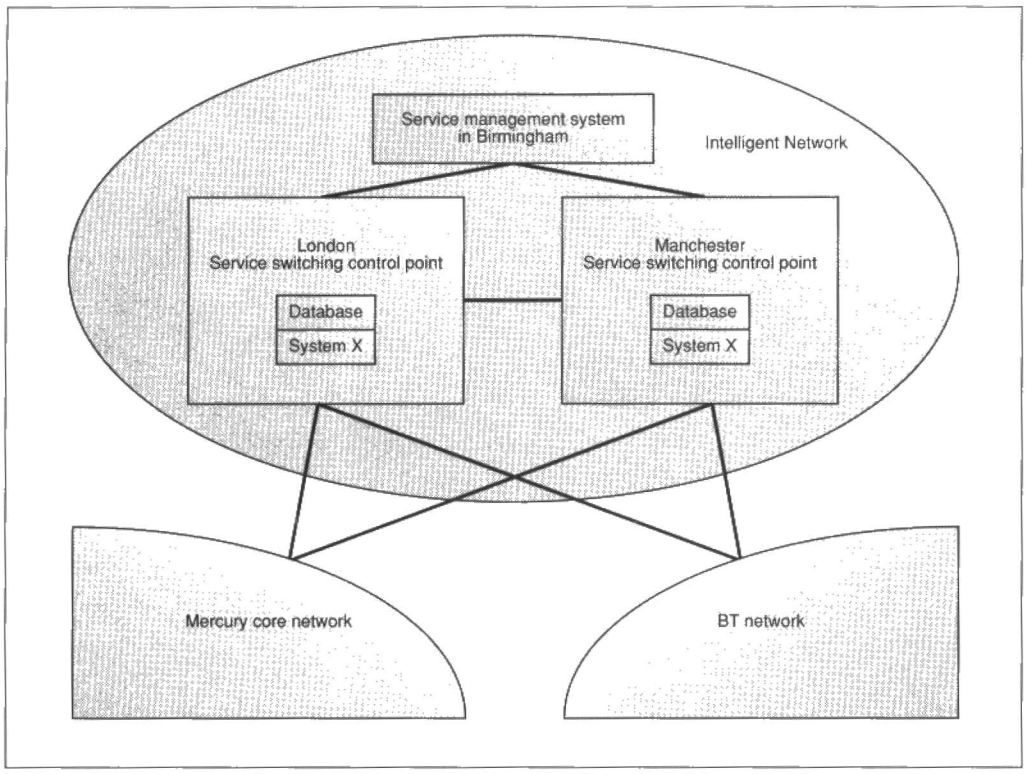
The manufacturer of the Kooler, PCubid, found that a number of requests for the device were from people who thought they had purchased new 50MHz 486DX50 machines. On removing the heatsinks from the microprocessor chips they discovered that, in fact, they were DX2-25/50. These run at 50MHz internally using Intel's speed doubling technology but the rest of the system, the bus, memory and so on, runs at 25MHz. Unfortunately, most PC speed test programs will say that such a system is indeed a 50MHz machine because the timing programs run within the on-chip cache memory and don't need to access the slower board memory. The lesson from this is that when buying a 50MHz 486 PC, make sure the whole thing is 50MHz and not just the insides of the microprocessor. ■

The Cyrix Cx486SLC microprocessor announced in the June edition of *Practical Electronics* has found its way into the portable computer market already. The Wyse DecisionMate 486SLC costs £1555 with 4Mbytes of memory and an 80Mbyte hard disk drive. Wyse: 0734 342200 ➤



▲ This plated through hole, double sided printed circuit board was produced by UK Electronics of Oldham. It measures 1219mm x 381mm x 3mm and has some 6000 connections and 100m of track. Used for a video surveillance systems, it must be among the largest PCBs ever made commercially.





Mercury Comm-unications has announced that from August, it will be using an twin computer system to control its exchanges. Used with 0500 toll free, 0645 local call and 0839, 0881 and 0660 premium rate services, the Intelligent Network automatically transfers calls to the correct number by means of a look up table.

In practice, two service control points and central switching points are used, one based in Manchester and one in Birmingham. On receiving a premium rate, toll free or local call number, the intelligent network translates the number dialled via a predefined table to a "translate to" number which is where the call will eventually end up. The advantage of using tables in a computer is that their contents can be changed at very short notice . They also offer facilities such as only routing calls to specific numbers at a certain time of day or day of the week, passing on the originating telephone number and making intelligent decisions on where to route calls depending upon the number of lines available at the receiving end. ■

In Brief

Pictures that used to be confined to PC monitors can now be displayed on a TV and recorded on video using the VGAPAL card from RDA – Tel. 0242 510760

Volunteers with some technical training who live in the London area are urgently needed by the Royal Institute for the Blind to help with the maintenance of its popular talking book service. If you can help, please contact David Finlay-Maxwell at RNIB 0484-450982 during the day, or 0484 604546 evenings.

Toshiba is to launch a new credit card sized modem for its T2200SX and T3300SL range of notebook PCs. They feature V21, V22 and V22bis as well as MNP4 and 5

Fujitsu Europe has extended its printer range with the introduction of the B100 bubble jet. Offering a resolution of 300dpi and a speed of 160cps, the machine costs £349. Contact Fujitsu Europe on 081 573 4444.

Toshiba in japan has announced reductions in the cost of its HDTV receivers. The 36in model will now cost ¥2.4 million (about £10,200) making it the cheapest in the market. Toshiba has also launched a new Hi-Vision 70in screen display unit at ¥10 million (£42,000). Since November 91, 8 hours of HDTV programming has been transmitted every day in Japan. ■

The Mini EL pictured on the right is one of a number of vehicles that took part in the electric vehicle rally organised by Eastern Electricity in Ipswich. Also in the procession were one of the most modern electric cars, the LA 301 and one of the oldest, an electric lorry.

The LA 301 won a major competition in Los Angeles USA to find an electric vehicle that could be used in the city yet contribute no pollution. Designed as a petrol hybrid, the car is built along very aerodynamic lines and has a range of 150 miles. ■

Apple's Newton

Apple unveils its long rumoured Newton Personal Digital Assistant – Arthur King reports.

Apple Computer, better known for its friendly to use Macintosh alternative to the ubiquitous IBM-compatible PC, chose CES to finally own up to the consumer electronics industry's worst kept secret. Apple announced it is to use some core British technology and its computer know how to enter the consumer electronics market with an advanced pocket computer called a personal digital assistant or PDA. Apple has formed a new division called PIE (Personal Interactive Electronics) to develop PDAs and there is a formal link up with Japanese electronics giant Sharp.

Sharp will initially manufacture PDAs for Apple and also build its own versions for the Japanese market. PDA system know-how will be licensed to anybody interested enough – a departure from Apple's reluctance to open up the Macintosh computer standard.

In Apple's own words, "PDAs are digital devices which bridge the gap between personal computers and consumer electronics." The first of these PDAs is to be called Newton, an "intelligent" electronic notepad which is likely to start selling early next year according to Apple supremo, John Sculley. The target price for Newton is around $800 (£450) or less. The notepad is designed to intelligently assist the user capture and organise information on the move. Apple is working on a number of projects which will form a family of devices all using core Newton operating technology. According to an Apple source if they don't sell millions of Newtons over the next few years the project will have been a failure.

The Newton shown at CES is a small device about the size of a filofax. It's a computer, but it doesn't have a keyboard and you can't run Macintosh or PC-compatible software on it. Instead Newton provides its user with a suite of utility programs using artificial intelligence managed by a brand new multi-tasking operating system linked to an advanced character recognition user interface. Commands are entered by 'writing' onto the PDA's LCD screen using a stylus. The writing appears on the screen as it is written, warts and all, but as soon as Newton recognises the characters it replaces your scrawl with computer-generated translations. It's a validation system which lets the user edit mistakes immediately – if you write the name "Graham" and "Granam" is returned – you just replace the 'n' with an 'h' using the stylus.

Newton also features an intelligent natural language command parser. The example given was that if you scribble "lunch Jane Thursday" as a schedule the Newton system translates this into a command sequence which equates to a lunch appointment with somebody called Jane at noon on the following Thursday. It will then delve into its database and suggest a particular "Jane" and ask you to verify the entry.

Character recognition is nothing new, but it is usually slow and cumbersome in operation, often because portable battery powered computers which offer the facility don't have enough processing horsepower to do the necessary computation.

This is where that British technology comes in. Newton uses a UK-developed RISC (reduced instruction set computer) microprocessor called ARM, which is short for Advanced RISC Machines. ARM Ltd is a spin-off company from Acorn Computers, which was originally responsible for the design of the BBC Micro. Apple and Acorn have an equal 46% share in Cambridge-based ARM Ltd, with the remainder owned by the US chip manufac-turer, VLSI Technology.

The ARM processor used is the new 610 model which comes from the same family of RISC processors originally designed in-house by Acorn to power the Archimedes workstation range. It's a 32-bit chip which delivers 15MIPs (million instructions per second) of processing power at a clock rate of 20MHz. This is significantly more powerful than an equivalent Intel 486 processor, which top-end PCs currently employ. Unlike the Intel chip, and other RISC chips for that matter, the ARM610 uses very little power – less than that used by a modest torch bulb according to Apple. Being small and relatively simple in design, ARM chips are very cheap too.

The tie-up with Apple is a coup for struggling Acorn which has not found it easy to sell its technically more advanced ARM-based workstations against industry standard PCs in its key education and hobbyist markets. Acorn's share price had rocketed by 500% by the time Newton was announced officially. ■

Summer CES In Chicago

The first of two reports from Ian Burley looks at the latest DCC, widescreen TV, digital watches that sense gravity and an LCD fish tank.

Practical Electronics regularly covers the consumer electronics scene in the States. This usually focuses on the twice-yearly Consumer Electronics Show (CES) which alternates between Las Vegas (winter) and Chicago (summer). Here is the first of a two part report on this year's Summer CES in Chicago.

Traditionally, CES is a trade-only event but to boost the declining summer event this year, the public was allowed in for the first time over the final two days. The audited figure for public attendance was over 90,000 in that period, a respectable figure but it didn't seem too busy.

The average punter was probably left feeling suitably dazzled by the exhibits, but the gaping holes this year's Summer CES line up certainly disappointedme. No less than JVC, Sony, Sanyo, Canon and Fuji, among others were missing from the main show floor. In fact Sony had a large number of new products (which we will cover next month) but was content to operate a mini-show out of its new downtown Chicago showrooms. A big surprise was the non-appearance of Commodore and CDTV. The computer company's CDTV multimedia system was launched in Chicago in a blaze of publicity just two years ago. Commodore's absence combined with the accelerating prominence of Philips' rival CD-I must place a big question mark over the future of CDTV.

DCC gets the hard sell in Chicago.

Technics' RS-DC10 takes DCC cassettes.

However, Panasonic/Technics, Toshiba, Sharp, Casio, Apple and most notably of all, Philips, were left to happily dominate. Philips probably deserved first prize for the biggest and most accessible stand with some of the most interesting leading edge technology on display- Digital Compact Cassette (DCC) and CD-I, including continuous demos of CD-I full motion video (FMV) (see PE last month for CD-I launch feature). However, Apple probably stole Philips' thunder with the out of show announcement of the Newton Personal Digital Assistant.

DCC was first shown at CES 18

RCA sports some wider screens.

months ago in Las Vegas. To recap, DCC is a digital audio tape format which Philips has developed from the ubiquitous analogue audio cassette which has been around for over twenty years. DCC decks can play both the new and old kinds of tape, a major advantage over Sony's failed DAT format. Philips' clever digital heir apparent to the compact audio cassette realm is just about ready to roll. DCC decks should appear in US stores in October. Initially these will be mainly high-end models from Philips and Technics. The former will sell for around $600 (£335) while Technics fits in higher up at the sub $1000 (£560) level. Philips subsidiary, Marantz, is will also introduce DCC decks this year.

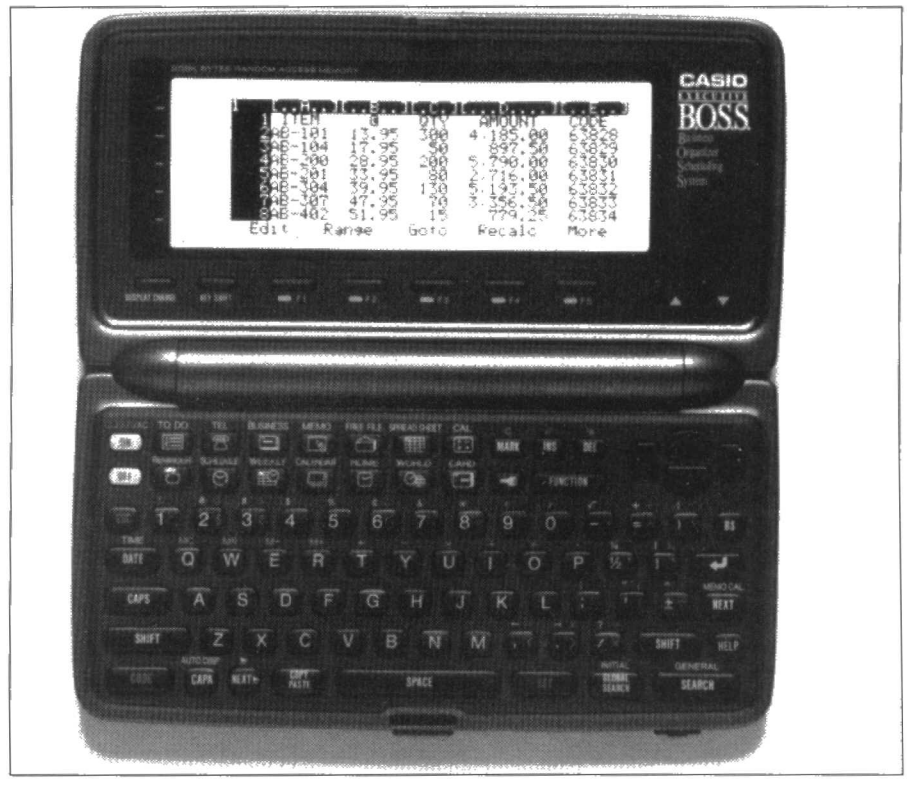
The prices are disappointingly high, but we can probably expect price cutting near to Christmas. It's interesting to note that that Sony aims to launch its rival MiniDisc system at roughly the same time but is clearly targeting the lower cost portable/walkman market which Philips will turn its attention to later. Don't forget they have cross licensed their respective DCC and MiniDisc technologies. Philips demonstrated in car DCC players, a market DCC's designers took very seriously with tough high temperature cassette specifications, but in-car DCC won't be available until next year. Both BASF and Panasonic announced the imminent production of blank DCC cassettes.

16:9 aspect ration wide screen TVs were much in evidence this year. Panasonic, Toshiba, Philips and Thomson RCA all showed wide screen models, though none of these are compatible with high definition TV (HDTV) broadcasts. US Federal authorities still have to choose a winner in the HDTV race and it's likely to be a couple of years yet before any serious HDTV broadcasting happens. Instead the punters were being introduced to the delights of watching wide screen video versions of their favourite movies or footage from an increasing number of camcorders which offer a wide-screen recording option. Toshiba even featured a battery of its widescreen sets, each TV dedicated to a repeated showing of a full length wide screen version of a recent feature film. If that wasn't enough, the Batmobile from the recent Batman movie was parked conveniently close by.

Staying with televisions, Panasonic was showing off its new SuperFlat tube which is claimed to be 30% less curved than first generation FST (flatter squarer tube) televisions. The new tubes have a claimed 46% improvement in contrast and an extra dark screen. A barium coated I-cathode electron gun is supposed to last longer and has improved edge focussing. Panasonic says its SuperFlat tubes can display resolutions up to 750 horizontal lines. This is in high resolution monitor territory and almost double the resolution of hi-band or S-VHS video. Some models have enhanced audio specifications which makes them more at home in a HiFi catalogue – dbx noise reduction and an onscreen graphic equaliser plus stereo surround sound decoding. Panasonic also offers twin-tuner sets which no longer need a video recorder tuner to feed the picture in picture facility. Then there's a fuzzy logic picture controller which continuously monitors the display and is capable of adjusting the contrast of one particular area of the screen.

Casio had one of the bigger stands at CES. The firm's two main attractions this time were its SF-R20 Executive BOSS personal organiser and a new divers' watch with electronic depth sensing. The SF-R20 BOSS is Casio's most ambitious personal organiser to date. 256K memory is supplied as standard and an

Casio's 256kbyte Business Organiser Scheduling System.



Also from Casio: left a ladies watch, centre the G-shock model and right, the diver special.

extra 256K can bring total capacity up to half a megabyte. A Lotus 1-2-3 compatible spreadsheet is built in and the various standard utility programs can be windowed on top of each other on the 40 character by 10 line LCD screen. The $450 (£250) Casio is about as far as you can get without actually qualifying as a pocket PC. A link up kit to exchange data with a PC or Apple Mac is an optional extra. It's serious competition for Psion's Series III organiser which has had rave reviews in the States.

From the company which brought you the wristwatch heart and blood pressure monitor, or the wristwatch weather station, how about the 'Depth Meter' or 'G-Shock' watches? Casio describes its Depth Meter watch (model SNK-100-9V) as a dive computer on your wrist. A built in sensor can tell you how deep in the water you are and it can remember the deepest you went as well as the duration of your dive. The $130 (£72) watch has a depth limit of 100 metres. If you want to go deeper, you may have to settle for Casio's G-Shock watch (model DW-6100-1V). This $90 (£52) watch forsakes the depth sensor for water resistance to 200 metres and offers a simpler temperature sensor.

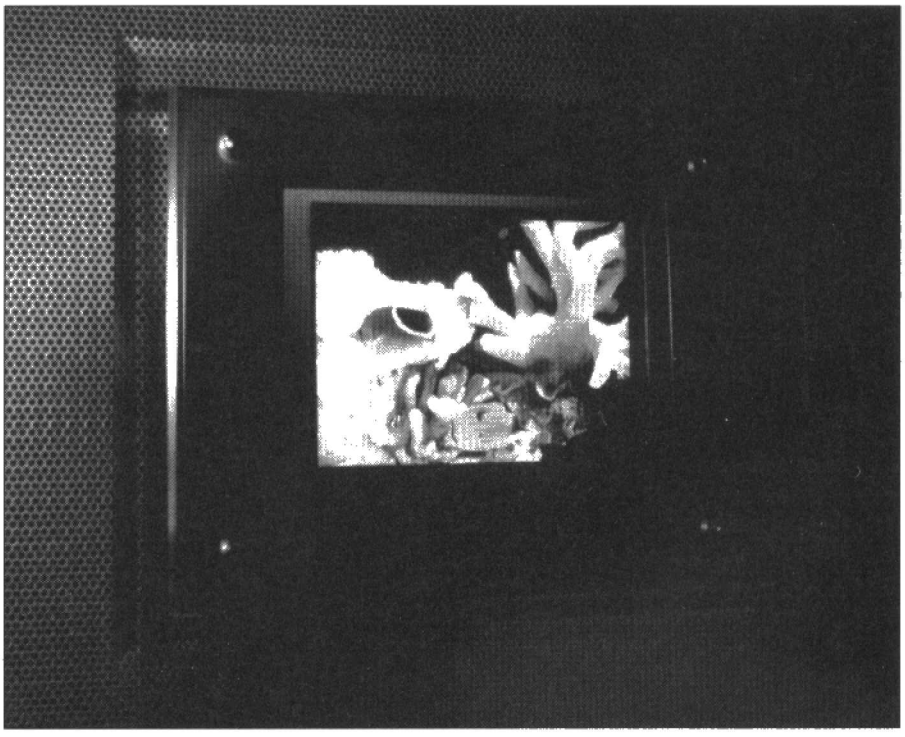
Sharp always offers an interesting pause during one's voyage through the the CES technology archipelago. Once again Sharp was showing its active matrix colour LCD prowess by feeding a scattered selection of wall-mounted screens with a stunning tropical aquarium view. I'm sure some of the visitors to Sharp's stand thought they were looking at the real thing. Less convincing was Sharp's colour LCD 'museum' display.

Hinting, perhaps, at what is to come with its recently announced collaboration with Apple on the Newton project, Sharp showed a much less ambitious yet impressive enough pen-sensitive personal organiser, the OZ-9600 Wizard (known as the IQ in the UK). The 9600 features a 320 by 200 pixel touch screen (up to 53 characters by 30 lines) but there's also a mini-QWERTY keyboard. The screen, which can sense fingertips as well as pens or styli, offers a multi-tasking and graphical user interface (GUI) complete with icons and windows. Unlike more advanced pen-input computers, the 9600 can accept scribbled input via the screen but there is no attempt to recognise written characters or diagrams. They are simply stored as graphical notes for later perusal by the user.

This has to be the simplest form of so-called electronic notepad. It's actually not as useless as it sounds. By managing where the scribbled information is stored, you have the convenience of a notepad over a keyboard and the vestiges of a database system. Utility programs include a calendar, to do list, three phone directories, business card directory, word processor, scrapbook, outline processor, calculator and a world clock. 256K memory is built in, the contents of which can be backed up to a removable memory card in just five seconds. Another feature of the 9600 which mirrors the Apple Newton is wireless communications. Files can be exchanged with external computers via optional infra-red transmitter receivers. Terminal software is also provided for modem connections to electronic mail services. The OZ 9600 won't be on sale until the end of the year and Sharp wasn't speculating on prices at the show.

That's all we have space for from CES this month. Next month we complete our CES roundup with a glut of new products from Sony and AT&T, plus a look at the US videogame price war and moves at the show to publicise digital audio broadcasting and interactive cable TV. ■

Sharp's LCD fish tank.



New Product Developments

Ian Burley looks at Sharp's latest IQ, Vortec and Olivetti's A5 computers, a new form of image enhancement and the world's smallest hard disk drive..

The World's smallest hard disk drive

Hard Disc In A Matchbox

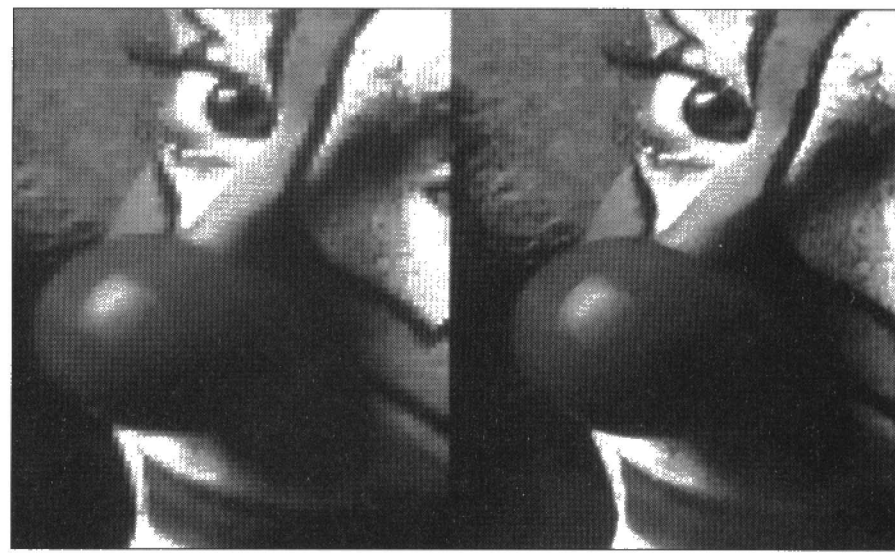
Hewlett-Packard has announced Kittyhawk, the world's smallest-yet hard disk drive mechanism – its glass platter is just 33mm in diameter and HP had to work with watch specialists Citizen in order to tackle the challenges of the unit's miniaturisation. US telecommunications and computer giant AT&T was also involved in the development of Kittyhawk.

Kittyhawk, which Hewlett-Packard describes as a Personal Storage Module (PSM), has a data storage capacity of just Over 20 megabytes yet the drive weighs less than a single ounce. Dimensions are 10.2mm high, 51mm deep and 36.6mm wide. HP expects that within a couple of years the capacity of future Kittyhawk versions could reach as much as 200 megabytes through the continued development of super-flat and rigid glass disk platters. Rival 1.8in hard disk drive technology which looked so impressive when it was introduced last year now looks obsolete, though these larger drive formats (including 2.5in drives) could survive through lower cost. At this level the smaller you get the more it costs to make the mechanisms, initially at least.

There are several other benefits inherent with tiny dimensions. Kittyhawk can withstand comparatively large levels of physical shock because all the components are very low in mass. HP says a Kittyhawk will survive a drop of three feet and can withstand ten times more shock than 1.8in and 2.5in mechanisms. A specially developed chip prevents head crashes by sensing when one may be imminent and lifting the head clear. The drive only consumes 1.6 watts of power in typical operation, falling to 15 milliwatts in sleep mode. AT&T's contribution to the project was to reduce the 18 or so chip count of typical mini hard disks to just seven.

HP sees Kittyhawk drive tech-

Improved images



nology as a serious challenge to other compact solid state data storage mediums like flash memory. The latter remains relatively expensive in high capacity configurations at around $50/megabyte while Kittyhawk will offer a cost of approximately $12/megabyte. 33mm drives are ideal candidates for the next generation PCMCIA expansion card standard which is based on very slim credit card sized devices.

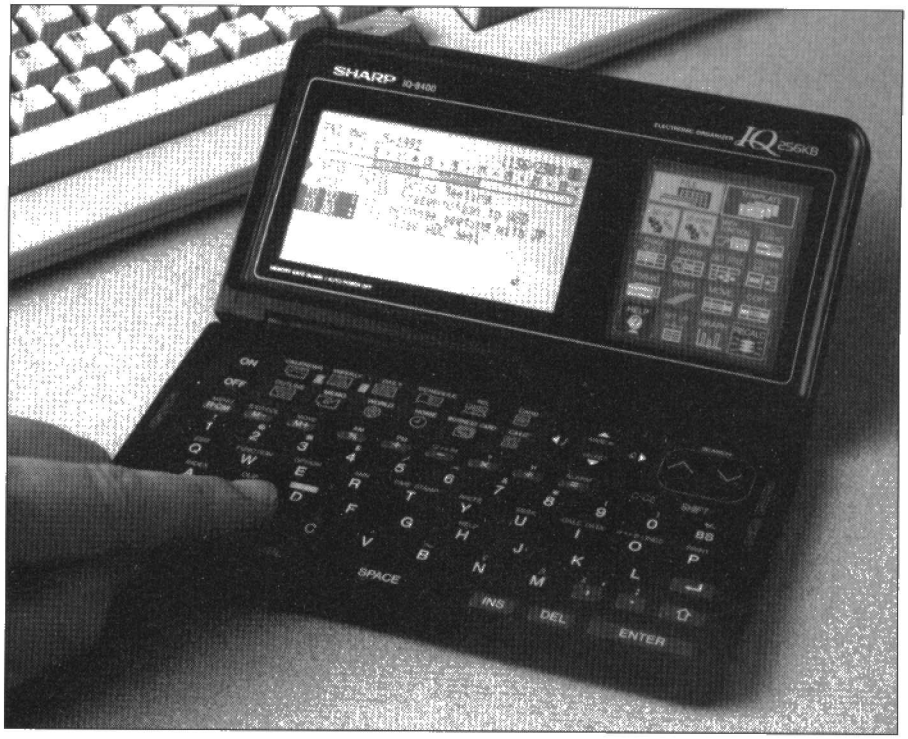
Fractal Enhancement

Following up its highly impressive hardware based Fractal Transform image compression system last year, Iterated Systems has now released a software-based compression system and unveiled a new Resolution Enhancement technology based on Fractal Transform techniques.

Fractal compression systems convert complex image components into compact mathematical formulae which take up very little space compared to the original data, typically as little as 1% of the original. Hardware acceleration was originally required to make the compression process fast enough for volume applications, but Iterated Systems has since produced a Microsoft Windows software-based compressor aimed at users who can't justify the cost of the PC card solution. Although comp-ression is time consuming, decomp-ression of FIF data (Fractal Image Format) is relatively fast and so doesn't require hardware accele-ration.

A criticism of fractal comp-ression by users who require very high quality images is that the compression process is not 'lossless' and side by side image comparisons before and after compression reveal tiny but visible discrepancies. Iterated's new Resolution Enhancement technology is a lossless system which improves the quality of displayed images considerably and is ideal, according to Iterated, for use with desktop publishing. Iterated Systems Ltd: Tel.0734 880 261.

The Comfax ad-on for the IQ.



The Sharp IQ-8400

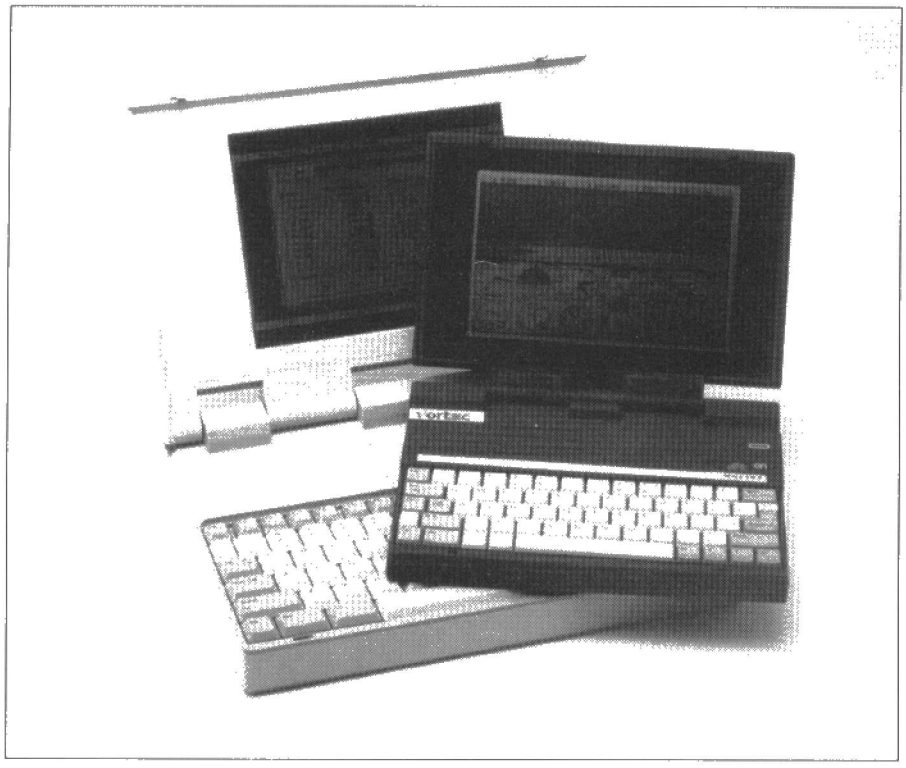
Sharp Raises Its IQ

A new flagship model has been added to the Sharp IQ personal electronic organiser range. The new IQ-8400 has improved utility software and enhanced communication facilities. New 'To Do' and 'Daily Schedule' functions have been added along with a VT-100 scrolling text terminal facility for use as a terminal via a suitable comms device like a modem.

The 290g IQ-8400 has a 40x8 character LCD screen capable of displaying pixel graphics. 256K RAM is built in, with 234K available to the built-in applications which include a To Do reminder, Calendar, Scheduler, Telephone directory, Memo, Outline processor, Business Card database and world time clock. Facilities available via plug-in IC program cards are accessible by touching a labelled screen on the IC card window – which Sharp seems to think is a 'touch screen' feature.

A nice touch is that the scheduler has a bar chart function to indicate your plans for the next 24 hours. The chart is accessible from a two month calendar display which can itself indicate up to three planned activities against each date.

You can connect your IQ-8400 to other IQ organisers via a special cable and transfer data between the two. Sharp also supplies an option-



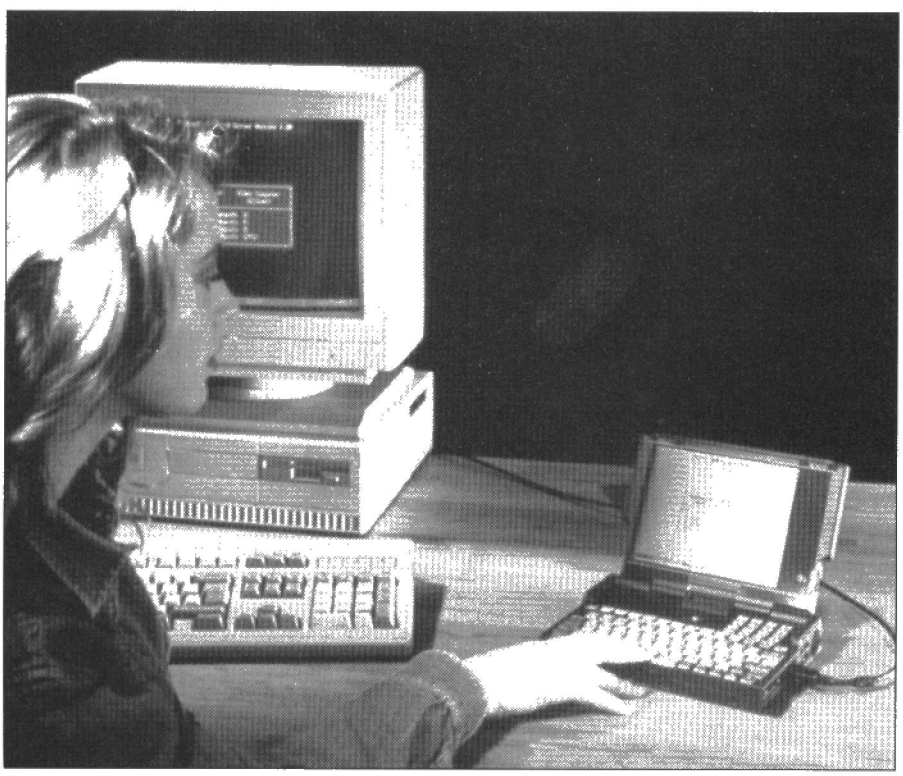
The new A5 size Vortec.

al Dataflex Pocket Comfax pocket modem for fax transmission of pre-prepared messages as well as data comms using the VT-100 terminal emulation. The IQ8400 can also be hooked up to an IBM PC compatible or an Apple Macintosh.

The Sharp IQ-8400 is priced £259 and looks set to give Psion's excellent Series III Organiser a run for its money. Sharp UK: Tel.061 205 2335.

Half Pint Computing

So-called Notebook computers which took no more desk space than an A4 sheet of paper took the PC world by storm three years ago. A4 seems small, but if you've ever used an A4 notebook you will probably agree they're far from pocketable and can be surprisingly bulky. So how about an A5 portable computer – half the size of the original A4? Two large corporations, Olivetti and Samsung/Vortec, recently unveiled their A5 PCs to kick off what could be a very lucrative market. PC compatibility and A5 dimensions may lump the Olivetti's Quaderno and Vortec' Booklet PC together, but in reality they offer quite different approaches.



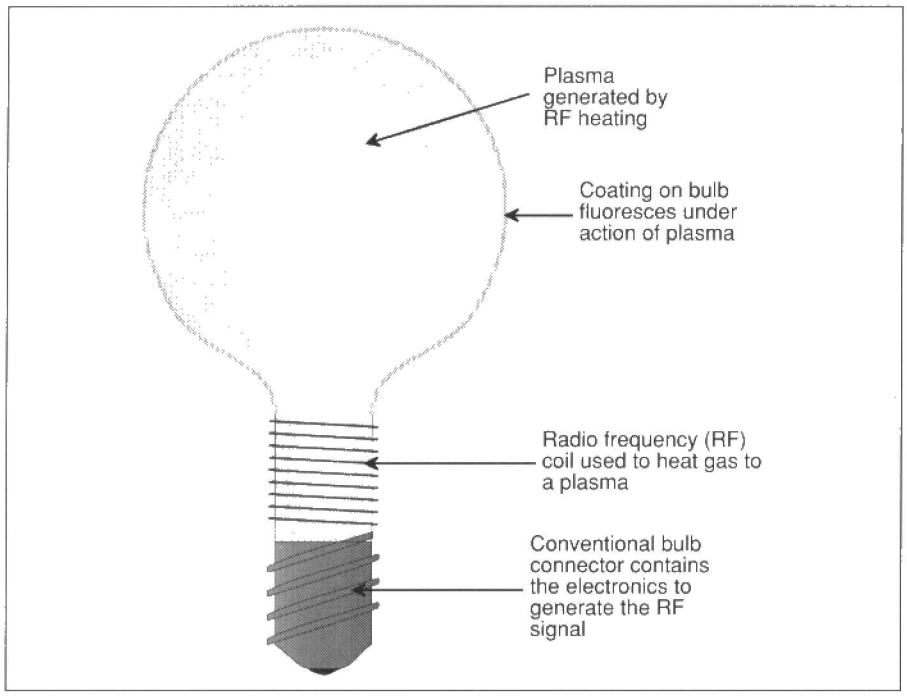
The Olivetti Quadermo.

The 1kg Quaderno is equipped with a relatively modest NEC V30HL processor. This puts it into the slower PC/XT class. The Quaderno is not designed for running processor hungry application like Microsoft Windows. However, you do get DOS 5.0 in ROM and a 20Mb hard drive, conveniently accessible personal management software applications and a voice memo recording function. Olivetti's marketing message is that the Quaderno has been designed to allow its owners the freedom to write, record, develop and transmit ideas, thoughts and decisions in any place at any time. In other words it's a grown up personal electronic organiser-come-dictaphone rather than a tiny desktop PC. A file transfer utility operating via the serial port is provided for exchanging files with another PC, like a desk-bound model.

The voice facility is an interesting feature which more PCs are now offering as standard – including the new entry-level PC range recently announced by Compaq. You can digitally record a message via a built in microphone and integrate voice files into text documents as voice annotations. The audio is recorded into files on the hard disk and can be manipulated using record, play, stop, pause and fast forward/ rewind controls.

Up to eight hours of use can be squeezed from the rechargeable battery pack, which is exchangeable for six standard AA penlight batteries should you be caught short. There is also an optional car cigar lighter adaptor.

1Mb RAM is standard and the DOS is stored in a 512K ROM. There is a single PCMCIA IC card expansion slot which can be used for solid state memory storage. There is no space for an integral



Artist's impression of the E-lamp.

3.5in floppy drive, but an external one is available. The screen used is a 7in LCD giving a 640x400 (EGA) resolution in 8 shades of grey.

In traditional Olivetti fashion, the Quaderno has had some decent industrial design applied to its case and the work of Mario Bellini has produced a stylish looking product. The Olivetti Quaderno is priced £699+VAT.

Vortec has taken another route entirely to its A5 PC solution. The Booklet PC, which also weighs 1kg, has a 16MHz lower power consumption version of the ubiquitous 286 processor. This means you can run Microsoft Windows on the Booklet without serious problems if you really must. A 40Mb hard drive (2.5in mechanism) is standard and options go up to 80Mb. 2Mb RAM is fitted. The screen is similar to the Quaderno's offering 640x400 resolution in 8 greyscales. All this extra power has to be paid for somewhere and with the added factor that the Booklet takes just five AA batteries (alkaline or rechargeable) compared to the Quaderno's six, it's not too surprising that battery life is just four hours compared to the Quaderno's claimed eight hours.

As with the Quaderno, you have to make do with an external floppy drive. A level II PCMCIA IC card slot is fitted to take memory cards or the latest miniature card modems or network adaptors. DR DOS 6.0 is stored along with the BIOS code in internal flash memory. Not only does this free up hard disk space and reduce the number of power-hungry hard disk accesses required, but DOS or BIOS upgrades can be installed without physically removing any chips. Personal management software is provided with the Vortec Booklet PC, but there is no voice recording system. The Vortec Booklet PC starts at £1599+VAT.

What we have here with the Vortec is a valid attempt to squeeze the dimensions and functionality of a desktop PC into A5 dimensions while avoiding some of the limitations of true pocket PCs like Sharp's PC3000 or the Poqet PC – neither of which have hard disk drives, for example. The Quaderno on the other hand is more like a very advanced personal organiser which has assumed PC-like functions. The two products differ sharply in price and expected application – definitely a case of different horses for different courses.

Olivetti: Tel.081 785 6666
Vortec: Tel.081 862 9311

Tuning Into Light

When someone promises to revolutionise something as basic as the common light bulb, they're bound to generate a lot of excitement. The spotlight has been shining brightly recently on California-based Intersource Technologies which is claiming that it has perfected a viable and economical replacement to the ageing and inefficient tungsten filament light bulb.

Intersource's new lighting device, dubbed the E-lamp, uses a high frequency radio signal to excite a gas enclosed in a glass globe. The gas becomes a plasma which makes a phosphorescent coating on the inside of the globe fluoresce and so emit light. Power consumption is about a quarter than of an equivalent brightness conventional light bulb and an E-lamp will never suddenly conk out. As it ages, an E-lamp will simply and gradually lose its brightness. An operating life fourteen times that of an ordinary light bulb is claimed too. That is supposed to equate to a typical life span of about 20 years. An E-lamp can be switched on and off instantly and can be dimmed – two key advantages over the currently available alternative efficient light sources which are compact fluorescent tubes. It's no surprise that an E-lamp is likely to be quite a bit more expensive to buy than an ordinary light bulb, but it should be cheaper than alternative fluorescent units which still usually cost over £10.

During the 1980s fluorescent replacements for conventional filament bulbs were also heralded as a major breakthrough, but the high purchase cost has deterred would-be buyers even though they are cheaper in the long run. The E-lamp is less bulky, works more like a conventional bulb and promises to be cheaper than a fluorescent replacement. Success must be guaranteed, or is it? The cynics, some of whom happen to be big producers of conventional light bulbs, say they are worried about the possibility of radio frequency interference (RFI) and there is still some anxiety that the price is still too high to woo buyers away from cheap and cheerful conventional light bulbs. Intersource is confident that it can answer its critics and has the multi-million dollar backing of Columbus, Ohio-based American Electric Power Co. which plans to be the first volume E-lamp manufacturer. We certainly haven't heard the last of the E-lamp. ■

Music On The Move

In-car entertainment systems have now become an essential feature of the modern car. Kenn Garroch takes a look at some of the latest technology.

In these days of high speed, high comfort travelling on the road, a good quality in-car entertainment system is rapidly becoming a fixture rather than an extra. Available systems range from basic radios offering FM/AM tuning with output into a simple pair of stereo speakers, to high power CD/Radio/Cassettes with a whole bundle of added extras including digital signal processing and RDS – a system that tunes the radio automatically. Indeed, some in-car systems now rival the power, quality and price of home based systems and in many ways they are easier to use.

How easy it is to use a car accessory such as a cassette player is vital in a situation where all of the driver's attention should be on the road. Any uneccesary distractions such as having to turn over a cassette or tune in to the best radio channel are to be avoided. The latest in-car HiFi systems are almost completely automatic where possible and require only a simple button press for most functions – there is virtually never any need to take your eyes off the road.

Elements

There is a wide variety of in-car HiFi systems available, from a number of manufacturers. In general, they all offer the same basic functions but usually under a variety of different guises.

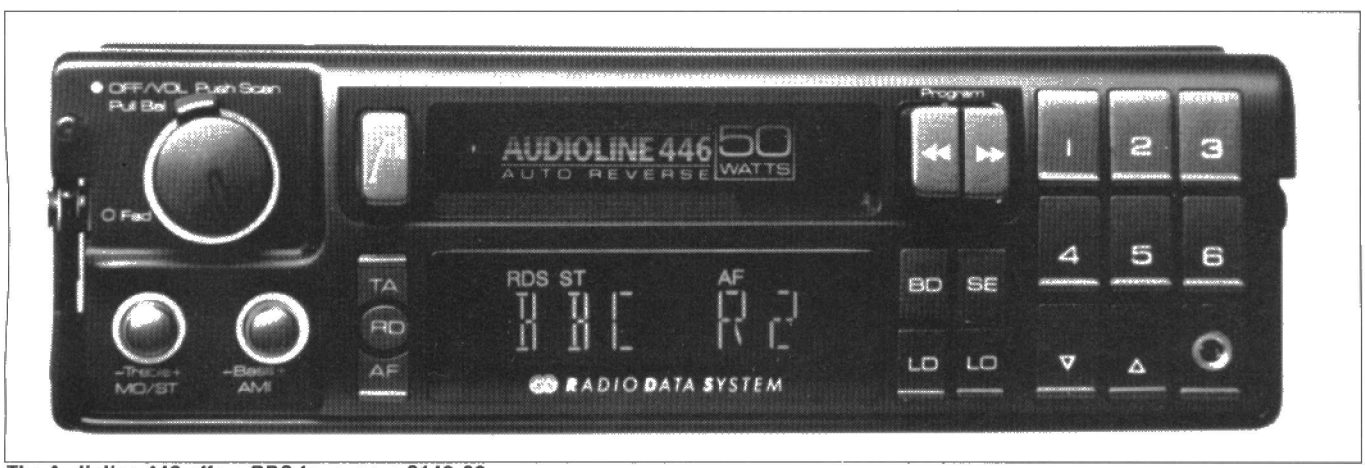
Cassette systems will usually have the ability to play both sides of the cassette (auto-reverse), one after the other. Rewind and fast forward (review and cue) are also generally available as is auto-stop. More advanced systems would also offer Dolby B and C noise reduction, auto programme search and blank skip, high quality cassette heads and metal/CRO_2/normal biases. In some ways, the cassette player is now the simplest unit in the system.

Unlike cassettes, car radio systems have become much more sophisticated over the past few years with the introduction of RDS (Radio Data System). In the bad old days, car radios had to be tuned by turning a knob until the desired program was found. More up-market systems had mechanical push-buttons that could be programmed to preselect stations.

The introduction of FM broadcasts on a European wide basis with increased quality of reception has lead to the problem that only small areas defined by the 'line-of-sight' are able to receive a signal from any one transmitter. Neighbouring transmitters have to use different frequencies otherwise interference would ensue and reception would be impaired. For static receivers, this is not too much of a problem – once the programme has been tuned to a preset, it need never be changed. In a moving vehicle the radio must be re-tuned every so often to keep on listening to the same station.

RDS provides a solution to the problem of retuning by transmitting a data signal along with the regular programme. This can be used to tell the radio where the next frequency is for a particular service. The radio can then automatically tune to the next strongest signal when the current one gets too weak. Of course, RDS provides a number of other services as well.

In these days of heavily congested roads, it is important to keep track of any traffic information.



The Audioline 446 offers RDS for a mere £149.99

Radio Data Systems

Until quite recently tuning into your favourite radio programme could be a fiddly business – most receivers tended to be left on one station, day and night. With the invention of RDS or Radio Data Services in the late 1990s all this has changed. An inaudible signal transmitted along with the usual mono-stereo information allows suitable radios to behave in an almost intelligent fashion.

The RDS signal is transmitted alongside the usual FM station information as shown below. Mono receivers tune into the mono signal and their reduced bandwidth ignores anything above it. FM stereo receivers have access to the mono and stereo difference signals. By combining the mono Left plus Right with the difference Left minus Right, adding them together gives L+R+L-R or L and L+R-L-R or R. The RDS signal is transmitted at three times the frequency of the pilot tone and can be picked up by suitably equipped FM receivers.

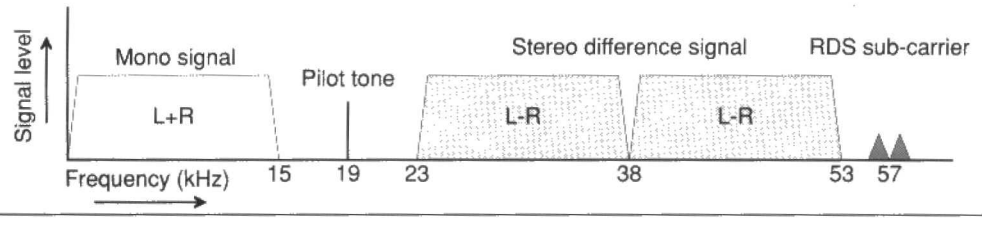
One of the main features of RDS is auto-tuning. Each station transmits its own unique code and for national stations the signals are transmitted on different frequencies depending upon the area. As a car and its radio moves from area to area, the radio automatically searches for the best reception of the particular station code. An additional feature is used in local radio where moving out of range would normally stop reception entirely. In this situation, RDS radios automatically tune to a related station, usually the area's local BBC radio transmission.

Another useful feature is used for receiving travel news. Stations which transmit travel information will also send out a TP (travel Programme) code over the RDS. When a travel announcement comes up a TA code causes the radio to tune into the relevant channel. When used with the enhanced other networks (EON) feature, this can be used to interrupt other stations, cassettes, CDs or even turn the radio on.

As with all "additional extras", not all radios offer all of the functions of RDS. A list of the functions and the standard codes is shown below.

PI	**Programme Identification**	Each station transmits a unique code that can be used in conjunction with the signal quality to obtain the best reception.
AF	**Alternate Frequencies**	A list of the station's frequencies tells the radio where to look for the best signal when moving between adjacent transmitter areas.
PSN	**Programme Service Name**	RDS equipped radios can use this to display the name of the radio station.
TP/TA	**Travel Service**	When stations transmit a travel news message, the radio will automatically change channels to receive it.
EON	**Enhanced Other Networks**	Cross reference information to other stations providing a similar service, for example other travel news.
CT	**Clock Time And Date**	Accurate calendar/clock which self-adjusts for time zone changes making sure that the radio's clock is always right.
PTY	**Programme Type Selection**	Allows the radio to select a type of listening rather than a particular station. There are 15 types of service classification: news, current affairs, information, sport, education, drama, science, cultures, varied speech (quizzes, comedy and so on), pop music, rock music, easy listening, light classical, serious classical, other music types.
PIN	**Program Item Number**	The radio can monitor whet is being broadcast and switch itself fully on for specific listening or to record a show. This then makes allowances for changes in scheduling.
RT	**Radiotext**	Information such as a cast list or the title of the current piece of music can be displayed of suitably equipped radios.
DI	**Decoder Information***	Various features of the radio can be turned on and off remotely with this feature.
MS	**Music/Speech***	The relative volume levels of music and speech can sometimes be very different or some people might not like listening to the DJ. This feature can be used to select the volume level for speech or music.
TDC	**Transparent Data Channel**	Data transmitted on the RDS channel can be downloaded to the radio.

RDS Features – * defines not in general use.



The Grundig WKC3880 offers RDS including full EON for £349.95

Radio stations that regularly transmit such material will also send out a TP or traffic programme code on RDS. The radio can then tune into the strongest such signal in the current area. An additional feature is the TA code which comes up when a traffic announcement is imminent. The radio can then retune, increase the volume and even switch from cassette or CD so that the announcement won't be missed. When used in conjunction with EON, the radio can tune into traffic announcements even when not listening to a TP station. RDS has totally revolutionised the way in which car radios can be used.

The other item in the car HiFi is the CD player. These can either be fitted on the dashboard and play discs in the usual way – shove them in and press go – or a multiple unit can be placed in the boot. This option adds to the security of the system as it cannot obviously be seen in the car. It also allows up to 12 discs to be stored in the player and any track from any disc played by remote control from the dashboard. The high quality and general overall ruggedness of CDs makes them ideal for in-car use. The only drawback is that should the car go missing (presumed stolen), a whole twelve discs go with it, as well as the player.

Amplifiers

One thing that is unmistakable about car HiFi systems is that they are getting louder. Up to 400W of power is now easily available by means of a separate amplifier. Usually, this is spread between a number speakers in the car which can be made up from small tweeters, mid-range, woofers and subwoofers. Some systems also offer a centre channel speaker to give stable sound localisation and enhance the stereo imaging. To add to the overall quality and give the sound some 'environment' a digital sound processor can be used. This adds different amounts of delay to the various speakers to simulate stadiums, halls and even cathedrals. In addition, an automatic road noise controller listens to background noises made by the car and can boost various frequencies to compensate.

Protection

One of the biggest problems besetting car HiFi systems has been theft. Since most cars are relatively easy to break into and the most valuable item in view is the HiFi a lot of work has gone into deterring thieves.

The most obvious solution has been to make the units removable. Simply lifting a handle and pulling removes the entire radio/cassette leaving an empty hole behind. The drawback with this is that every time the car is left anywhere, a bulky box must be carried off by the driver. If the HiFi is accidentally left in the car, it becomes even easier to steal.

Another solution to the theft problem is to provide individual code numbers for each system. Entering the right code allows the system to work, the wrong code disables it completely.

Yet another solution to the problem is a removable facia plate. This is small enough to fit in a pocket but without it, the HiFi won't work. When used in conjunction with a code number, this technique can be quite effective.

Almost all modern HiFi systems offer some form of security feature. When considering the cost of the equipment and the high risk of losing it, it has become an essential feature. ■

The Panasonic CY-DA3000 digital signal processor offers complete surround sound.

Armour Plated In-car Cassettes

Arthur King checks out a new audio cassette from Sony that has been especially designed to withstand the rigours of being on the road.

If you drive a car and use an in-car cassette more than occasionally, you're bound to have suffered the inevitable tangled tape scenario. If you think about it, unless you happen to run a super smooth Roller with air-conditioning powerful enough to freeze a small town, a car dashboard must be one of the worst places imaginable to site a tape cassette mechanism. Heat attacks from all angles – the greenhouse effect of a car parked in hot sunlight with the windows closed, heat seeping in from the engine compartment, the heating system and even heat generated by the cassette player's own electric motor. But that's only half the story because vibration and shock coming from both the engine and the road, takes things from bad to worse. Then again it astonishes me how a cassette, and even the driver survive the mega-watted blasting (mostly at ridiculously low resonant frequencies) which some people appear to enjoy enduring and spend literally thousands of pounds on in power amplifiers and woofers to achieve. I personally long ago abandoned the idea of trusting any car stereo with my best HiFi recordings. My car tapes are all back-ups of the originals and all eventually end up looking like an audiophile piranha has been at them.

Tape manufacturers, especially in the US where people spend a much larger proportions of their lives cocooned in a car, have become wise to the fact that the promise of a reliable cassette tape designed specially with car stereos in mind can be a much needed boost to flagging sales. Indeed Philips went to great lengths to stress how much research and development had gone into the formulating heat and vibration resistance specification targets for the new digital compact cassette (DCC) standard. Even if DCC, which HiFi buffs

feel has a compromised sound quality, doesn't take off in the quality HiFi stakes it should remain popular for in-car systems. The comparatively noisy insides of even the most refined Roller means that DCC's admittedly good sound quality won't be judged 'not good enough' for a long while yet. DCC had to appeal to the car stereo manufacturers right from the word go and DCC's designed-in ability for its cassettes to withstand continuous 40C environments was one way of providing the required appeal.

Sony has produced such an armoured car-tape of the more conventional variety. The Super Chrome Position UX Turbo (sic) C90s we've been torturing have all survived intact. The cassette shells are identifiable by being unfashionably short on clear plastic window areas exposing the tape reels – opaque plastic is stronger than the transparent stuff. For extra rigidity the shell halves are welded together rather than bound by screws. Sony claims the plastic it uses can withstand 115 Celsius. Even the self-adhesive labels supplied are guaranteed not to peel off and migrate to the most delicate parts of your car stereo's tape transport mechanism. Surprisingly Sony's attention to in-car requirements don't seem to have extended to the delicate stuff which does a good job of wrapping itself around capstan rollers. According to Sony specification sheets the tape itself is identical to ordinary UXS90 stock. This isn't half bad as Sony claims UXS has the least bias noise (-60.5dB) of any super chrome position tape. Other nice Sony touches include a non-slip grip for those changing-the-tape when one should be changing gears moments around multiple mini-roundabouts plus extra lumpy dimples for you to feel which side of the tape is which without taking your eyes off the road.

I could probably be tempted to spend the extra dosh on UX Turbo tapes, especially if the hot summers we've been getting in recent years are here to stay. ■

Sony UX Turbo 90 Tapes are available in twin packs at a recommended retail price of £3.99 per pack – note that some retailers may offer reductions on this.

How it works .... Engine Management

Derek Gooding opens the bonnet of his car to find out what is inside the black box that controls the engine.

Surely there is no comparison these days between the electronics under the bonnet and the very early days of the first petrol driven automobiles? Those 'Good ol' days when the roads were always clear, except for the herds of sheep or cattle. The open road. Next time you have the opportunity of a close look at an early vintage car, you will notice a number of levers around the driving position that we don't have to worry about today.

'Advance/Retard, 'Suction'. Such controls were fine for the enthusiasts willing to experiment and really learn how to drive, but more ordinary mortals would soon be in the driving seat.

Manufacturers have eventually developed engines that are so user-friendly, the owners seldom lift the bonnet to see that all is well and few would be able to understand the systems involved let alone be able to repair them.

Feedback

From the early days car engine designs have followed a pattern of complex mechanical feedback systems that produced a reasonable degree of engine protection and a smoother ride. Modern electronic systems also involve feedback; control of fuel/air mixtures; fuel injection; surge suppression; battery charging, and engine temperatures.

The drawing shows a Lucus Engine Management System unit with its transistor circuits, this is a replacement unit for a 1970's car, but at least we can see inside it. These days a 'black box' encapsulated approach is used to protect the circuitry and it is worth knowing that to cut open a modern box, after it has ended its useful life, is to be avoided, especially if the unit has been subjected to very high temperatures.The resulting liquid is very damaging to ones health.

Full microprocessor control units are now in service as car management systems, these enable stepper motors to operate and control the carburettor setting; if the tick-over of the engine drops to the point where the battery charging ceases, the feedback automatically causes the engine to speed up to a point where charging recommences. Sometimes 'knock' begins in one cylinder and does the engine no good at all, but the feedback to some microprocessor car systems actually enables immediate reaction to the knock sensor's message and can retard just the one cylinder until the loading problem has passed.

Long term aims of the big manufacturers is to satisfy the demand for vehicles offering higher performance, better fuel economy, longer service intervals and lower emission levels. Even the humble spark plug is about to go back into the laboratory for a full reapraisal so the future is looking good for motorists.

Early Attempts

Many unfortunately remember the early days of electronic ignition systems where, without warning, the engine would just die. Some accidents may have happened because the electronics 'gave up' just as the driver put their foot down to complete an overtaking manoeuvre. One journalist always carried two 'spare' units when test driving the new electronic box of tricks and on a number of occasions was forced to use them in replacement to finally get home again.

Maybe next time you see a veteran car rally, or the London to Brighton drive in November – where they celebrate the passing of the red flag safety walker who was forced by law to proceed any moving automobile – you will notice the fact that the driver is working much harder than any modern driver. But it's nice to know that in many ways the early drivers had it very easy indeed, for they only steered the vehicle .

In The Past

In the days of steam powered road transport the poor coal stoker at the back would control the power source for the driver. Coal dust experiments to ignite inside an engine cylinder proved difficult if not impossible but led to the development of the crude oil engine.

Soon petrol driven automobiles were on the road, making the stoker redundant. Owners found the fun of steering had gone and they were expected to learn the complexity of the many levers, adjusters and techniques of the 'new age' machines. Is it not to be expected that few continued to want to drive but instead re-deployed their stoker as driver. The French call their stokers: 'Chauffeurs'. ■

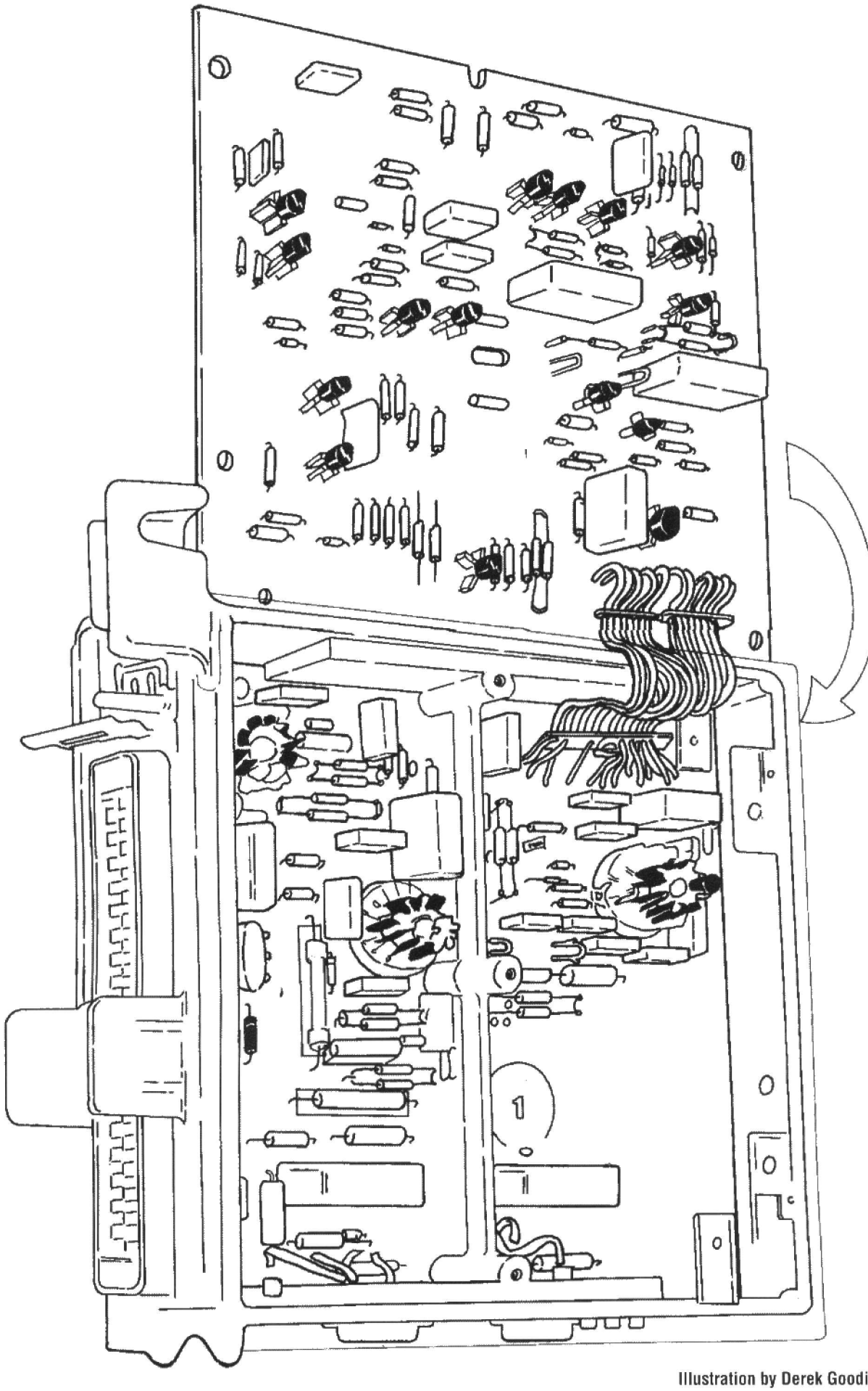


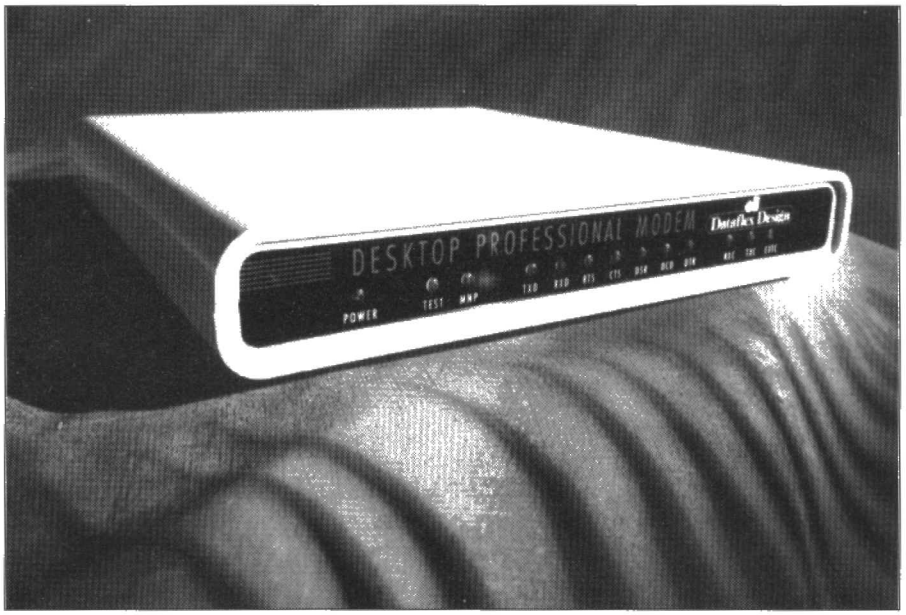
Illustration by Derek Gooding

Getting Wired Up And Going On-Line

All you need to know to go about connecting up to the wide world of Computer Communications with Steve jackson.

Many people may be thinking about buying a modem and going on-line with their computers but are not really sure of what is involved. The following pages aim to shed a little light on communications for computers, and answer some of the more common questions.

Owning a modem opens a door to a new world. It enables a small computer to access a vast network of information which is quite literally world-wide. A modem brings the ability to connect to other computers to transfer programs, data, text files, news, exchange messages with other users and much much more, all at a press of a key. The possibilities are almost endless.



Equipment

To get on-line, various pieces of equipment are needed. In general, any items discussed in this article will apply to most types of computer system.

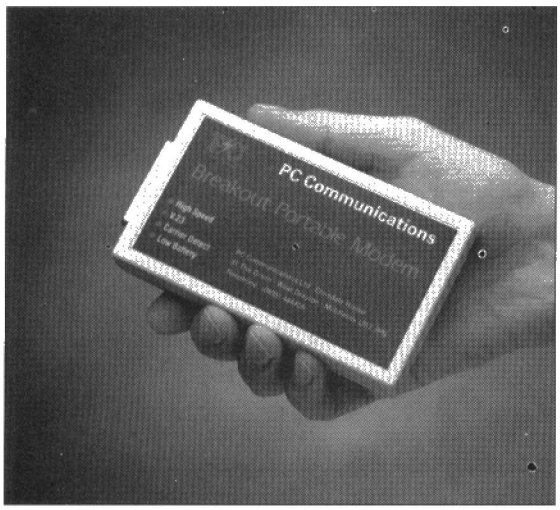
Obviously, the first requirement is a computer able to provide some means of connecting to a modem. This is usually via a serial port of which the most common type is the RS-232 – a widely used standard throughout the world. All PC compatible computers have a serial port, usually known as "COM1". Machines such as the Amiga, ST, Archimedes and Apple Mac also have serial ports which adhear to the same standard. Older machines, such as the Commodore 64, may require an interface of some kind maybe or, perhaps, a dedicated modem designed for that machine.

Unless they are based on an expansion card, most modems will connect to your RS-232 port via a serial cable. This can be purchased complete from most computer suppliers but they are quite easy to make up if you prefer – a couple of connectors, some cable and a soldering iron are all that are needed. In practice, serial cables using the RS-232 standard can vary in complexity. The most basic cable only requires use of three pins – transmit data, receive data and ground. More complex cables can include data flow control and signals to show if your communications and computer equipment are actually on-line .

At the other end of the cable from the computer is the modem itself. There are hundreds of different makes and models available; so much so that there is not room to go into them all here. Instead, a look at the main specifications and modem types plus a rough guide to the price of each – this is always an important factor of all computing topics, should give some idea of what to bear in mind when buying.

One of the oldest types of modem is the acoustic coupler. There aren't many of these around today, but they can be seen used in films such as War Games. With an acoustic coupler devices telephone numbers are dialed manually with a normal telephone. Once the remote computer system can be heard answering the handset is placed into the coupler. This allows the computer and the remote system to exchange data. Unfortunately, acoustic couplers are not very reliable. They are prone to interference from the outside world and they only operate at very slow speeds – this makes them an option not worth considering in practice.

The next step up from an acoustic coupler are the older, but more reliable, manual modems. These come in various forms but use the same basic design and operation. Compared to more modern



modems they are a little dated but very cheap. These devices must be configured manually via switches and dials usually located on the front panel. Again, telephone numbers must be manually dialed but the difference is that the handset doesn't have to be placed into a coupler. The normal procedure is to simply flick a switch once the remote system replies and then put the handset down. Interference is not much of a problem but manual modems are limited in other ways. They can probably be picked up for under £50 second hand – it would be rare to find a new one nowadays. Speeds supported would be V21 and sometimes V23 (300/300 and 1200/75 baud respectively).

The Best

The best type of modem to look at is an automatic modem. The most common types are Hayes compatible and they all work in much the same way even though actual specifications may vary. Most of these modems can be controlled through software from the computer, although they often have manual switch settings available if you need them. Hayes compatible modems use commands that are issued via the keyboard of a computer or automatically by the communications software. This language allows you to completely configure the modem and use all its features. All have automatic dialling so there is no need to use a conventional telephone. The modem will also be able to autoanswer, so if there is an incoming call, the modem will pick up the line and carry out the connection by itself.

The most basic type of Hayes compatible modem will offer V21 and V23 operation. Next up is V22 (1200 baud) and then comes V22bis (2400 baud). Most modems are downwardly compatible, that is, a V22bis modem will work with V22, V23 and V21. A V22bis modem will vary in price but it is possible to pick them up for under £100. This does depend on the manufacturer, whether it is new or not, and what features it has. The most widely used standard is probably V22bis. It offers an acceptable transfer rate and is pretty much error free in most conditions.

Noise on the telephone lines can always be a problem when using a modem and a high transfer speed is sort after because it cuts down on the phone bill. The problem here is that the faster the modems talk to each other, the more prone they are to interference. This is where error correction and data compression come into play. Some modems are advertised with such options as MNP 5 and V42bis. Modems of this type, when connected to a modem which offers the same facilities, will provide completely error free communications. They will also compress the data so that a greater throughput is achieved. Unfortunately, this causes the price to start rising – over £100 in most cases. The thing to bear in mind is that the greater throughput the shorter the call time will be. This means a saving on phone bills, so in the long run it is worth while paying more for a faster modem.

Moving on to the top of the price range there are modems with very high speed capabilities such as V32 and V32bis modems. These offer speeds of 9600 baud and 14400 baud and although the price of modems is falling all the time, a first class machine can easily cost over £400 pounds and, in some cases, over £1000. Again, this depends on whether the device is new and who manufactures it. Just about all of these modems have error correction and data compression built in. Some of the connection speeds which can be obtained are quite amazing. This sort of modem is especially useful for transferring large files that would otherwise take an unreasonably long time to carry out, using V22bis, or lower.

Systems To Go

01 For Amiga – BBS – 071 247 9240
CIX – Commercial – 081 390 1255
Compuserve – Commercial – 071 490 8881
Computer Pages – Free Commercial – 081 751 1494
Cyberspace – Commercial – 071 580 6433
DTP – BBS – 081 656 5190
MAX – Large BBS – 0905 52536
PDSL – BBS – 0892 667091
TUG 2 – BBS – 0905 775191
Most BBS systems have a list available of other systems that you can dial up, these are just a selected few.

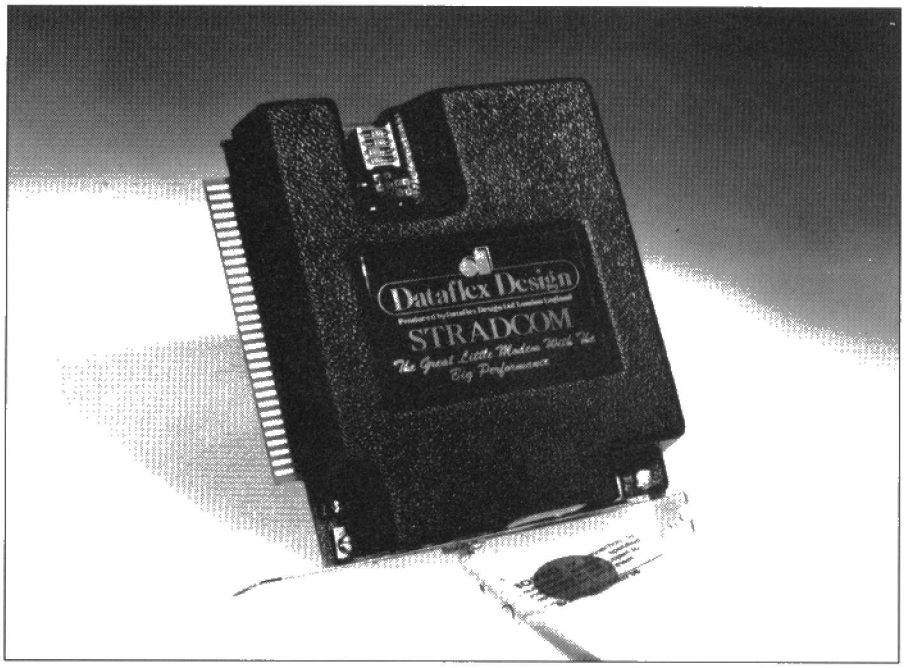
Software

To drive the serial port and modem a communications software package is needed – again there are plenty to choose from but all of them do much the same thing. As with most types of software there are both commercial products and packages which are available via Public Domain (PD) and shareware sources. It must be said that most of the commercial packages, save one or two, don't compare favourably to what is available through shareware and PD. People who are involved with communications are

Common Modem Standards

V21	300 baud, transfers data at 300 bps full duplex
V22	1200 baud, transfers data at 1200 bps full duplex
V23	1200/75 baud, receives data at 1200 bps and transmits at 75 bps full duplex
V22bis	2400 baud, transfers data at 2400 bps full duplex
V32	9600 baud, transfers data at 9600 bps
V32bis	14400 baud, transfers data at 14400 bps
V42	Error correcting protocol for modems. Packet based error detection and retransmission technique
V42bis	Data compression algorithm. Simple and compact technique giving up to three times the data throughput
MNP	Miracom Networking Protocol Error control in MNP 1 to 4 and data compression in MNP 5

often very devoted and this shows in the hobbyist software that is produced. Both shareware and PD programs can be freely distributed, often only costing the price of a disk and, in the case of shareware, a registration fee. A good PD library or a friend should be able to supply a reasonable program and once on-line it is possible download other communications programs without having to wait for the disk to arrive in the post. A good commercial package to look out for on the PC is Transend Professional and a decent Shareware/PD package, which is widely available, is PROCOMM.



Services

Once the computer, cable, modem and software are set-up a whole new world opens up. There are a variety of services available, some of which are free and some which have to be paid for. The most common type of communications system which can be contacted via modem is the bulletin board. 90% of these are run from the home by enthusiast as a hobby. There are hundreds in the UK alone and hundreds, if not thousands, around the world. On calling a bulletin board for the first time it will usually request details such as name, address, telephone number and so on. From there it will probably present some information about the system, what it has to offer and various bits of the latest system news. It will then present a menu system which will allow the choice of various procedures and options. There are files which are available for download from the bulletin board or on-line service to your computer and messages from other users. Some systems even allow games to be played against other people who call the system, or in the case of multi-line systems play against someone in real-time. Most bulletin board systems are free to use, apart from the phone bill incurred when calling them. Some of the larger systems do ask for a small donation and many have subscription fees.

There are also commercial on-line systems available which have to be paid for. This sort of system will offer a great deal of information, access to lots of other users and is often just a local phone call away. The subscription charges vary depending on what facilities you require and the service in question.

The world of comminications is developing and expanding rapidly while the cost of accessing it is falling. All that is needed is to buy a cheap computer, cable, modem and software to start exploring it now. ■

Modem Glossary

ARQ – Automatic Repeat Request, a general term for error control

Asynchronous Transmission – Data transmission in which the length of time between transmitted characters may vary, applies to the sort of modem referred to in this article

Autoanswer – A feature in modems enabling them to answer incoming calls

Autodial – A feature in modems enabling them to dial phone numbers without the aid of a conventional telephone

Baud – The number of discrete signal events per second occurring on a communications channel. Although not completely correct, baud is often used to mean bit rate

Bits per Second – BPS for short, the number of bits transmitted per second via a communications channel

Carrier – A continuous frequency capable of being either modulated or impressed with another information carrying signal

CCITT – A international organisation that defines standards for telephone equipment, for example, the modem standards

Data Compression – The modem compresses data received from the computer, transmits it to the remote modem, where it is then uncompressed and sent to the remote computer

DCE – Data Communication Equipment for example a modem

DTE – Data Terminal Equipment for example a computer

Download – The transfer of data from a remote to a local system

Duplex – Indicates a communications channel capable of carrying signals in either one direction at a time (half duplex) or in both directions (full duplex)

Error Control – various techniques which check the reliability of characters or blocks of data

Flow Control – A mechanism that compensates for differences in the flow of data input to and output on a modem

Local Echo – A modem feature that allows the modem to send copies of keyboard commands and transmitted data to the screen

Local System – Usually refers to your computer

Modem – A device that transmits and receives computer data through a communications channel such as a telephone line: stands for modulator, demodulator

On-line – A connection is made between two modems for example

Remote Echo – A copy of the data received by the remote system

Remote System – A computer system located a distance away

Serial Transmission – The transfer of data characters one bit at a time

Synchronous Transmission – A form of transmission in which blocks of data are sent at strictly timed intervals

Upload – The transfer of data from the local to the remote system

Multimedia Comes Of Age

Rod Allen visits Multimedia 92 and finds a fascinating collection of interactive video, computers and software.

In the last two to three years the term multimedia has gone from being a buzz word for an idea to a buzz word for some real technology. The recent multimedia show at Olympia in London was a showcase for a wide variety of computer, video and sound systems.

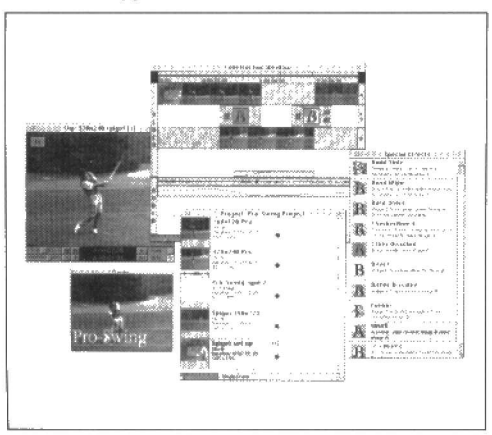
Using computers to control video information and sound as well as their interaction with people is at the heart of multimedia technology. Some systems are complete in themselves – Philips CD-I and Commodore CDTV are good examples of this. Others are simple enabling technologies such as touch screens or video interfaces for computers. Still others are computer programs that allow current systems such as PCs and Mac to create and manipulate moving pictures and sound.

A picture drawn with Autodesk 3D Studio.

Interactive Entertainment

The two main competing systems for home multimedia market are Commodore's CDTV and the recently launched Philips' CD-I. Both had large stands at the show with a number of machines available to play with.

Apple's Quicktime in action.



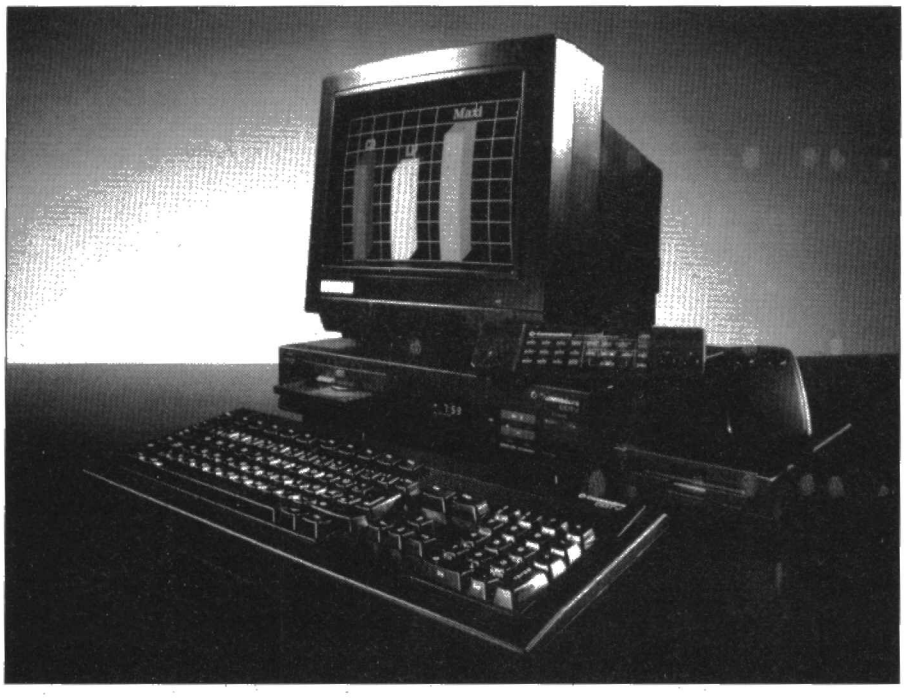
The Commodore system is based around its Amiga computer technology and is, in some ways, handicapped by this. The machines on show produced reasonable sound and pictures – about what you'd expect from a computer games machine. The CD-I system, on the other hand, had a much more professional look and feel. Time will tell which one wins out in the battle for the home multimedia market but my money is on CD-I.

Touching Technology

Evident at the show was a plethora of touch screens. These were being used on demos of everything: ATM machines, how to find your postcode using the Royal Mail's CD-Post code system, a complete guide to the show with touch-screen maps of the exhibition and as a mouse replacement in general MS-Windows applications.

The technology of touch screens falls into three main categories, resistive, surface acoustic wave (SAW) and capacitative. Resolutions of up to 4000x4000 points are available and SAW systems are also pressure sensitive so that they not only sense the position of a finger on the screen, they also know how hard it is pushing. This can be used for dragging and clicking or in process control where things must be turned on and off.

The screens can be attached to almost any monitor – Ellinor reckon to make about eight or nine screens in each standard size to fit all of the



Commodore's stylishly black CDTV.

different makes and types of monitor. With an estimated life of about 1,000,000 touches for each point on the screen, they should last a lifetime and start appearing in the high street real soon now.

On-Screen

As display technology is important to multimedia, it was to be expected that there would be a large number of gadgets designed to improve picture quality and help interface to various sources of video information.

One of the drawbacks with the latest PCs and Macintosh computers is that they output their video information in a format that is totally incompatible with most VCRs. Among others, VideoLogic, Multimedia Italia and Magnifeye were providing solutions with cards or plug-ins that output PAL signals. Using these, the computer can be used to generate a sequence of images which can then be recorded on video tape to be spliced together with other sequences, resulting in a totally computer generated programme.

Software

Apart from the hardware, multimedia is intimately involved with computer software. In general this produces some impressive results – with the aid of some hefty processing power. Two of the more impressive packages on show were Apple's Quicktime and Autodesk's 3D Studio.

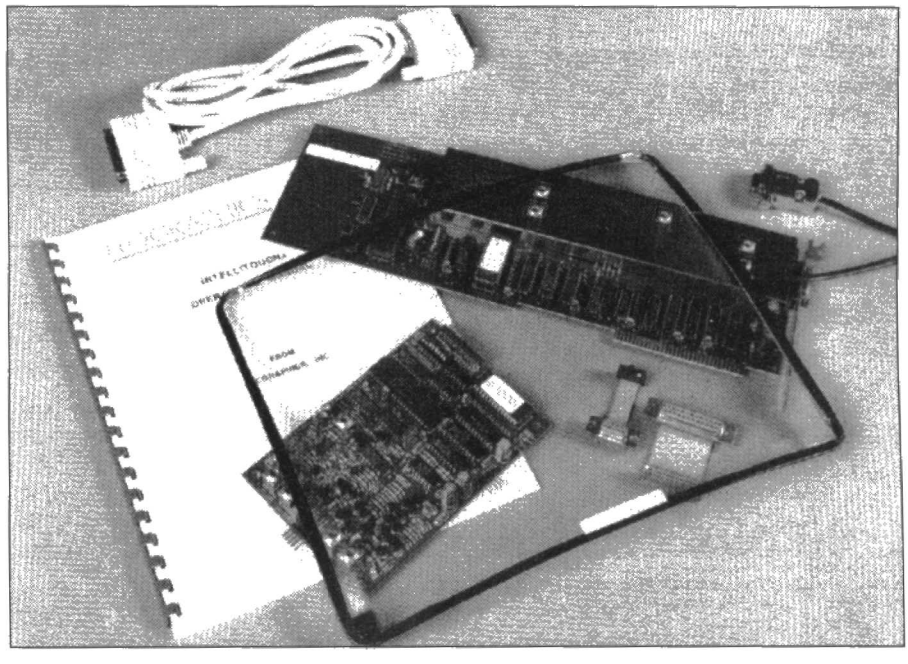
Quicktime is an add-on to Apple's new System 7 operating system and allows the integration of video and sound into the Macintosh's graphical user interface (GUI). This is done in such a way as to allow video information to be passed from application to application without the need for any conversion or incompatibility problems. Able to run on all standard Macs, video sequences of between 10 and 24 frames per second can be viewed in a window on-screen. Images can be sourced from camcorders or VCRs via a plug in card and incorporated into presentations or learning packages. The big advantage of Quicktime is that the whole thing integrates seamlessly with the rest of the operating system.

When it comes to life-like images, Autodesk 3D studio is going to be hard to beat. Images are made up from a 3D wire frame model, each point of which can be easily position in 3D space. A rendering system then lays over this skeleton a perfect three dimensional rendition of any texture required using a predefined light source and viewing position. The texture can be a standard such as silver or wood grain, or can be scanned in to allow custom patterns to be used. The full colour results are so life-like that it is difficult to tell them from a photograph. Some of the main applications are in 3D modelling or the creation of mock-ups for design purposes.

Multimedia To Come

With applications in learning, training, point of sale, graphic design, communications, entertainment plus many others, multimedia has finally come of age. If the products on show at Multimedia 92 are anything to go by it will be appearing all over in the very near future. ■

Ellinor's touch screen system.



A Transistor At The Crossroads

The unijunction transistor is one of the simplest semiconductor devices, yet it can be used in oscillators, trigger circuits, and delay circuits.Samuel Dick reveals all.

The unijunction transistor, first investigated in the late 1940s, is a three terminal device just like a normal transistor. However, while transistors owe their operational characteristics to two semiconductor junctions, the UJT as its name implies, has only one. This earns the device its alternative name of 'double base diode'. The UJT's symbol is shown in Fig 1. The device has an emitter and two base connections. Looking at the silicon structure of the device, it is fabricated from a single silicon bar formed from N-type silicon with a single junction of P-type semiconductor formed on the bar (Fig 2). Fig 3 shows a simplified equivalent circuit.

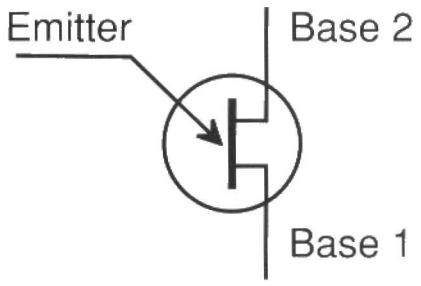
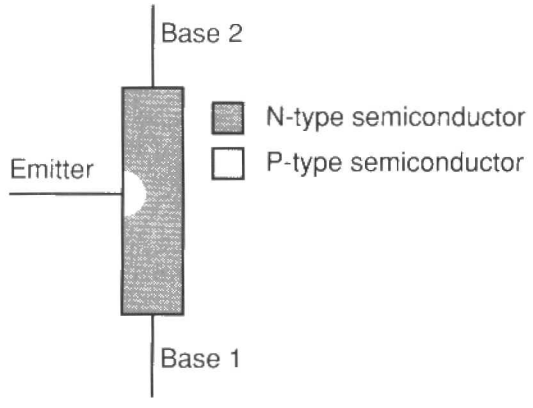


Fig. 1. Symbol for the unijunction transistor.

If we ignore the emitter connection, the resistance across the bar is a few thousand ohms. In normal operation, the Base 2 connection is made positive and current flows down the bar. Since the bar behaves like a simple resistor, the voltage seen at the point where the emitter connection is made is some fraction of the supply voltage, the exact value depending on how far along the bar the emitter junction has been made. This fraction is known as the 'intrinsic stand-off ratio' and has the symbol η. The stand-off ratio typically has value from 0.4 to 0.8; the commonly available 2N2646 device has η between 0.56 and 0.75. The intrinsic stand-off ratio is an important characteristic of the UJT because it determines how the device works as a trigger.

Fig. 2. Physical structure of the UJT

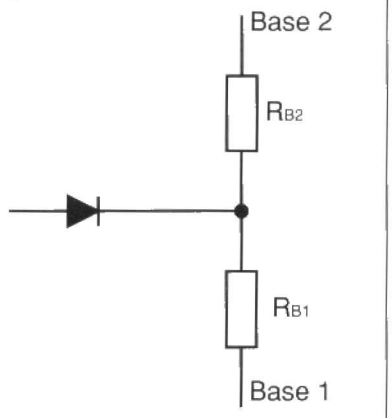


In the equivalent circuit, the emitter is connected to the device via a diode: the voltage on the emitter terminal is less than that seen at the junction (that is, η times the supply voltage), only a small current will flow out of the device. Since this is the leakage current of the 'diode', its value is very small: currents of a few nano-amperes may be expected for normal operation conditions. In this state, the current flow from Base 2 to Base 1 will also be small – only be a few hundred micro-amperes.

When the voltage on the emitter is increased so that the diode in the equivalent circuit is forward- biased – turned on – then current begins to flow in R_{B1}. This reduces the value of R_{B1} so the voltage difference across the diode is increased. This allows more current to flow from the emitter into the device, further reducing R_{B1}. This sets up a run-away condition during which the device can conduct quite heavily. The peak current for the emitter in a 2N2646 is 2 Amps! But note that the maximum Root Mean Squared (RMS) emitter current (the maximum average current) is only 50mA; the 2 Amp limit only allows for the rush of current when a capacitor is connected between the emitter and ground.

If the voltage supply on the emitter is such that it cannot be maintained above the value required to keep the junction conducting, the device will cease conducting and return to the 'off' state.

Fig. 3. Equivalent circuit for the UJT.



The UJT Oscillator

This is how the UJT is used an oscillator. Fig 4 shows the circuit: R_2 and R_3 need not be considered for the moment. When power is first applied to the circuit, the capacitor, C_1, is discharged and so Ve is zero. C_1 now charges up because of the current flowing through R_1. Left undisturbed, the voltage across C_1, Vc, would eventually equal the supply voltage, Vs. However, when Vc reaches the point at which the emitter is forward biased (ηV+0.7 Volts), the impedance seen through the emitter suddenly decreases and the UJT becomes a low resistance connected in parallel with C_1. The result is that C_1 initially supplies a large current through the UJT. This flow of current discharges the capacitor and so lowers the voltage on the emitter. At some point, the voltage on C_1 is no longer sufficient to keep the junction forward biased and the UJT suddenly switches off. Now the voltage on C_1 will slowly rise again because of the charging current via R_1 – the UJT will only affect this process slightly since the leakage current through the reverse biased emitter will be very small (<1μA).

Hence, the whole cycle will repeat every time Vc reaches the trigger voltage, a pulse of current will flow through the UJT. The increased current causes the voltage across the two base resistors, R_2 and R_3, to momentarily increase. Point A has a negative-gong pulse while Point B has a positive-going pulse. The amplitudes of these pulses depend on the values of R_2 and R_3.

The frequency of oscillation is controlled by how quickly C_1 can charge up again following a discharge pulse. by careful choice of R_1 and C_1, frequencies from much less than 1Hz to near 1MHz may be obtained.

The pulse from the UJT may be used to drive a loudspeaker or piezo-sounder (Fig 5). It may also be used to trigger some other circuit.

Trigger

Another use for the UJT is as a simple trigger device. By connecting a resistor (Rc) in parallel with C_1, a voltage divider is formed. The voltage fed to the emitter (with the UJT 'off') is VsR_1/Rc. While this voltage is below that required to trigger the UJT into conduction (ηVs+0.7 Volts, with R_2=R_3=100Ω), no current flows and so the voltage on Base 1 is =0. But when Vc exceeds the trigger voltage, the voltage at Base 1 increases to =1 Volt. This change could be used to trigger some other circuitry. But note that UJT's are made with a wide range of η so repeatability, from device to device, would not be very good – each circuit made would have to be set up individually.

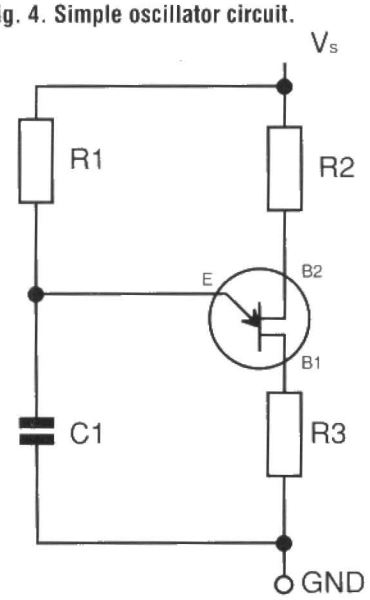
Driving Thyristors

One of the most common uses of UJTs is as trigger devices for thyristors. The simplest application is a time delay circuit – either to turn a load on or off after a certain time,

In Fig 6, when power is first applied, the emitter of the UJT is at zero volts. The Base 1 is also nearly zero volts since only the ohmic leakage current of a few hundred microamperes is flowing through the UJT. The voltage on the capacitor will gradually rise and , at the trigger point, will turn the UJT on. The time taken for this to happen will depend on the time-constant of R and C; with 1MΩ and 2.2μF a delay of around 3s is realised. Once the UJT is triggered, the resulting pulse of current will create a voltage pulse across R_3 which will be seen by the gate of the thyristor and so turn it on. The UJT will continue to pulse but this does not matter since only the first pulse is required to turn on the power to the load – subsequent pulses are ignored.

The 'turn-off' circuit in Fig 7 is rather more complicated. Here, the thyristor which drives the load is

Fig. 4. Simple oscillator circuit.



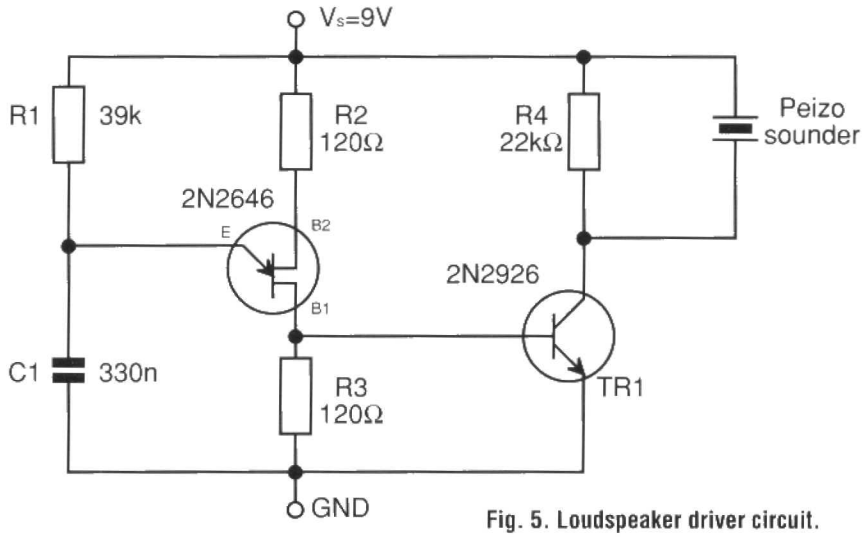


Fig. 5. Loudspeaker driver circuit.

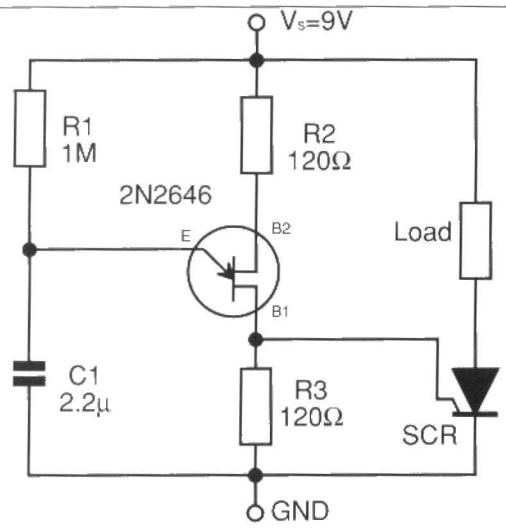


Fig. 6. Thyristor trigger circuit – delayed turn-on.

will switch off – and will stay off until another pulse is applied to its gate. The most obvious way of decreasing the current through the thyristor is to momentarily disconnect the load. A more subtle way is to divert the current into a capacitor for a short interval – only a few microseconds are required. This may be achieved by connecting a capacitor across the anodes of two thyristors as shown. By switching on the thyristor not connected to the load, the capacitor is grounded. The negative pulse fed to the load thyristor turns it off. By using the delay turn-on circuit of Fig 6 to fire the second thyristor, a delayed turn-off circuit is obtained. ■

switched on immediately the power is applied, since its gate receives a pulse through C_2. Once this initial pulse has turned on the thyristor, the gate is held low by R_4; power continues to be supplied to the load since thyristor is not latched on.

Once a thyristor has been triggered, it will stay on until the current flowing through decreases below the holding current. The value of the holding current depends on the current capacity of the thyristor; low power devices have holding currents of only a few milliamperes. Then the thyristor

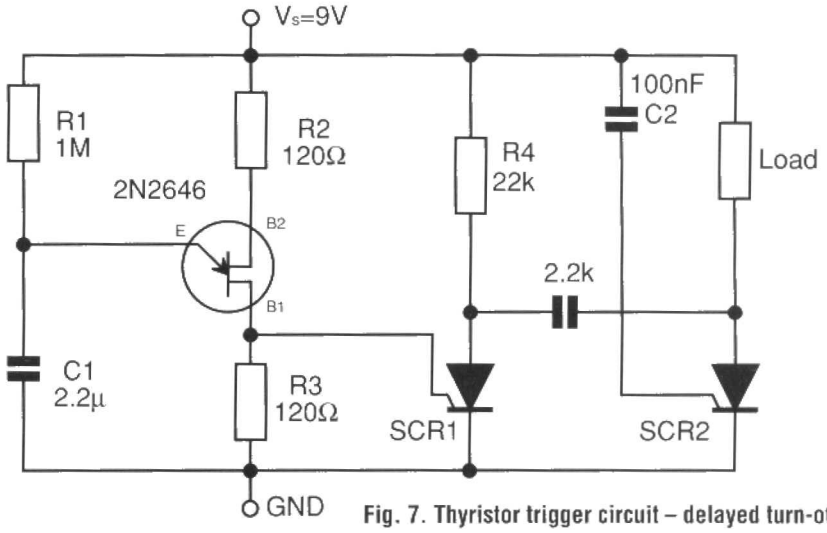


Fig. 7. Thyristor trigger circuit – delayed turn-off.

New Technology Update

Ian Poole reports on new techniques in solar cell construction, wide bandwidth amplifiers and improvements in integrated circuit manufacturing.

Solar cells are seen by many as a very convenient and environmentally friendly source of power. However, to compete with more conventional forms it is estimated that their costs must fall by a factor of at least five. With existing semiconductor technology it is unlikely that this can ever be realised even if it is optimised to give the best performance. If solar cells are to provide a viable alternative source of power a totally new approach is required.

This may now be possible with a new technique developed in Germany. It involves a low cost technique for depositing a substance called cadmium telluride (CdTe). This enables efficient thin film CdTe solar cells to be made on inexpensive substrates including ordinary glass. By using this technique it is hoped to cut production costs to about a fifth of their current levels whilst still achieving efficiencies of just over 10%. It is also expected that by further development even higher efficiencies will be possible later.

Although a number of different materials can be used CdTe was chosen as the best. In tests it gave one of the highest conversion efficiencies. In addition to this it was rugged and provided a high degree of stability.

The new process is based around a specialised sublimation technique which produces polycrystalline CdTe films very rapidly on a variety of substrates. The process requires the use of a temperature of around 650C in a partially evacuated oven containing an inert gas. The CdTe source is located close to the substrate. At this temperature the material sublimes and then "condenses" onto the substrate which is held at the lower temperature of 500C.

At the present time the process is still in its laboratory stages. However work is now progressing to develop a suitable production process. This is likely to take three years or more because this work needs to be undertaken very carefully to ensure that production costs are minimised.

Once the cells are in production it is estimated that there will be a large market in view of the growing demand for remote and sustainable energy sources.

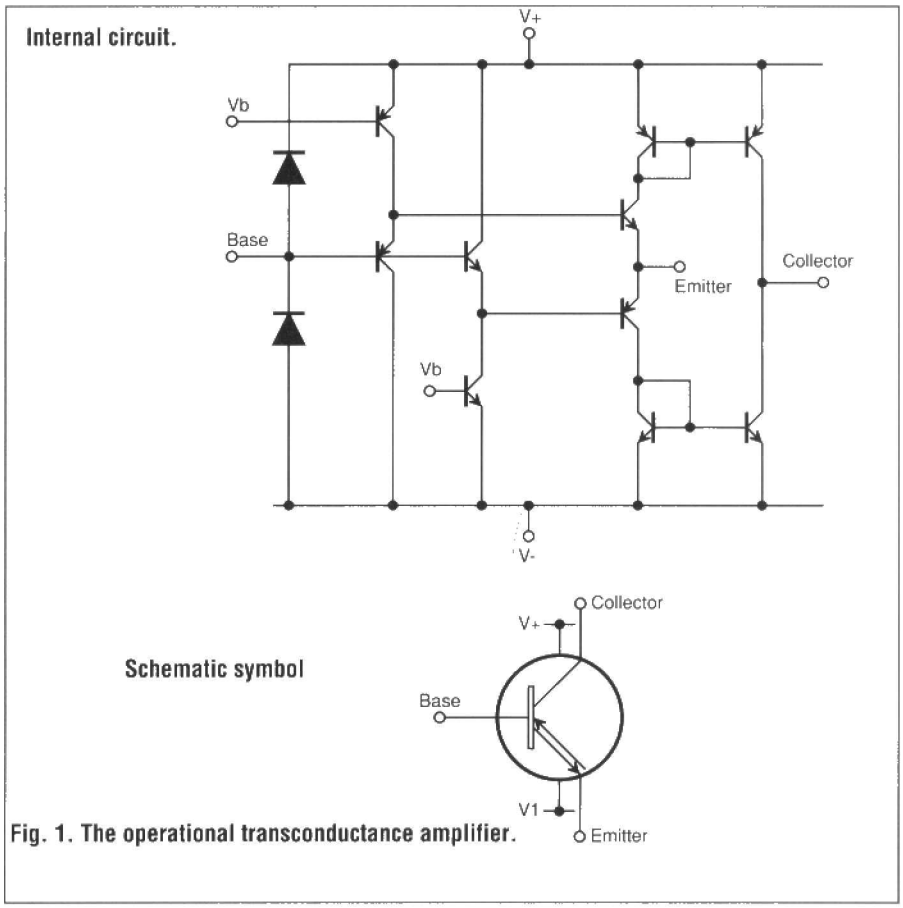
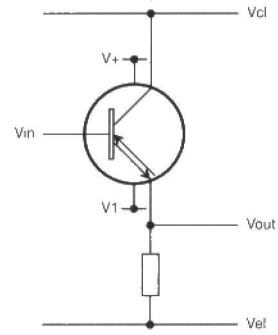


Fig. 1. The operational transconductance amplifier.

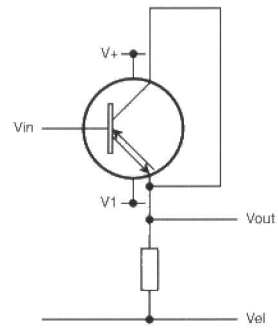
New For Wide Bandwidths

The quest for wider bandwidth analogue ICs has lead Burr-Brown to develop a new type of circuit. Called the "diamond transistor" it functions as a voltage controlled current source or Operational Transconductance Amplifier (OTA). This new circuit has proved itself to be useful and versatile in a number of applications. It can be used as the basis for either a voltage or current feedback operational amplifier.

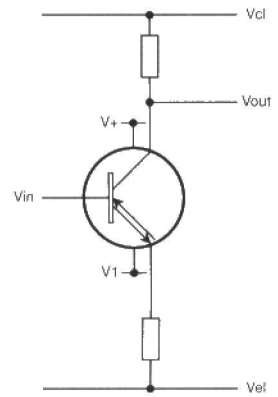
The basic circuit consists of ten transistors and has a total of five



a) Conventional form of common collector emitter follower.



b) High current form of emitter follower



c) Common emitter configuration

Fig. 2. Various configurations for the operational transconductance amplifier.

external connections. Two are for the power rails, but the remaining three are associated with the signal paths and are called the base, emitter and collector. These names are used because of the similarities have to the transistor ones. In the first instance the circuit can be used in the basic emitter follower configuration to give an impedance transformation and higher current capability. However there are some differences because it is possible to connect the collector to the emitter to increase its current capability.

The amplifier can also be used in a common emitter circuit. Again it shows many similarities. However it is found that there is a difference in the fact that the OTA does not give the standard 180° difference between input and output which is a characteristic of a true transistor circuit. Instead both the input and output signals are in phase.

In operation the base has a high impedance. Any voltage changes at this point cause corresponding current changes in the emitter circuit. When current flows into or out of the emitter it is mirrored by the circuit for the collector. The ratio between the emitter and the collector is fixed by the internal parameters of the circuit making the circuit a complementary current source where the actual value of the current is determined by the voltage on the base.

To achieve a good high frequency response the circuit is fabricated using a complementary bipolar process with vertical transistors. These devices have very high transition frequencies, typically 3.5GHz for NPN transistors and 2.7GHz for PNP. This means that the whole amplifier is able to achieve a bandwidth of 350MHz and a voltage gain of 4 when connected in an open loop configuration.

Although the circuit is used on its own the manufacturers expect its main use will be when it is incorporated within larger analogue ICs. As such it is only just beginning to see its full potential.

Improvements in ICs

Standards of cleanliness have to be exceedingly high in the production of semiconductor devices. ICs in particular demand very high standards. Poor cleanliness results in low yields and low long term reliability. This all means that if a manufacturer is to maintain his reputation, then cleanliness is of the utmost importance.

To improve standards Philips at Eindhoven has developed a new method for drying silicon wafers. Drying is often needed because the manufacture of a number of devices including ICs and liquid crystal displays often involves processes which use wet stages. These processes are usually followed by rinsing the wafer and then drying it. Once dried, traces of chemicals in the water are left on the surface of the semiconductor. These traces can greatly reduce yields and long term reliability.

Standard techniques involve rinsing the wafer and then spinning it to remove most of the water. This is not entirely satisfactory because some water still remains on the surface. In addition to this some stress damage can occur during the spinning.

To overcome these problems a vapour of a water soluble compound like iso-propyl alcohol is directed at the point where the wafers emerge from the rinsing bath. At this point the water absorbs the alcohol and as the wafer rises up out of the water a meniscus is formed. It is found that there is a larger concentration of alcohol at the top of the meniscus than at the bottom where it can be absorbed by the water more easily. In turn this causes a gradient in surface tension which encourages the water to flow off the wafer and back into the bath. This results in clean dry wafers emerging straight out of the bath without any need for spinning or drying. ■

Build An Auto-Ranging Tuning Fork

This month's project is an all electronic way of tuning musical instruments to an accuracy of one eighth of a note. John Becker explains how to build it.

Players of acoustic and electronic music instruments can all benefit from this tuning aid. Consisting of a frequency counter and electronic look-up table, it analyses a musical input signal and displays data about its octave, note and tuning accuracy on three banks of LEDs (light emitting diodes). Data is split into 12 notes per octave, encompassing six octaves across the frequency range 54Hz to 2047Hz. Tuning accuracy is to within one eighth of a note. A reference tone generator is included as an optional extra. Acoustic instruments are monitored via a microphone input and variable gain preamp. Electronic instruments may be plugged in directly.

The block diagram for the complete tuner is shown in Fig.1. Fig.2 shows the main control and display circuit, excluding the reference tone generator.

Timing Control

Sampling of the musical input frequency is carried out at a rate of 1Hz. A master clock frequency of 32768Hz is generated by the crystal controlled circuit around IC1a. IC2, a 12-stage binary ripple counter, divides this frequency by 4096, producing an 8Hz output at its Q11 pin. One half of the dual 4-stage binary counter IC3 (IC3a) further divides the rate by eight. The positive-going edge of each 1Hz square wave pulse at IC3a's QA2 output triggers one half of the dual monostable IC4. The resulting anti-phase pulses at pins 6 and 7 of IC4 control the latching of the LED-driving control registers IC6 and IC9-IC11. R3 and C4 set the latch pulse duration to about 1 microsecond. When IC4 pin 7 reverts high at the end of the timed period, the positive-going transition triggers the second monostable within IC4, resulting in a positive-going pulse from pin 10. This is the system's master reset pulse and its duration is set at about 1 microsecond by R4 and C5.

Toning Up

The principal input to the circuit is via the pre-amp stage around IC5a. Electronic instrument signals may be connected directly to this stage. Alternatively, a high-output microphone may be plugged in for monitoring acoustic instruments. VR1 is a panel-mounted control which sets the stage gain to between x1 and x100. The output from IC5a is fed to the comparator stage around IC5b which further amplifies and squares the amplitude of signals above the hysteris threshold set by R8 and R11 in conjunction with the reference level set by R9 and R10.

Passing via S2, the outputs are

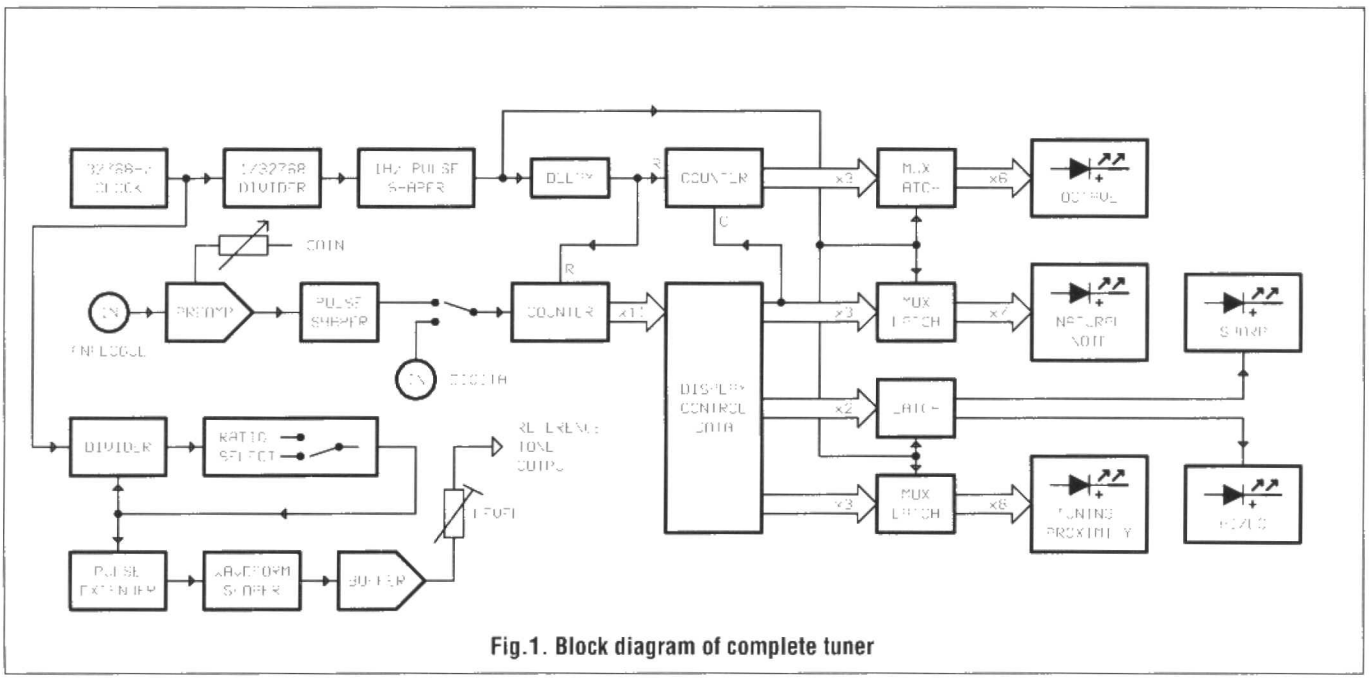


Fig.1. Block diagram of complete tuner

brought up to full line level by the Schmitt inverter IC1c and provide the clock pulses for the 12-stage binary counter IC7. Electronic musical instruments producing constant-amplitude pulses may be brought directly into IC1c via the second path of S2. The maximum amplitude may be between about 4V and 9V. The minimum amplitude should be less than 1V but not significantly lower than 0V.

IC7 counts the output pulses received from IC1c over a period of exactly one second and its outputs provide the address code to the look-up table held within the EEPROM (electrically erasable programmable read only memory) IC8. The memory holds data codes which provide information on how the sampled frequency relates to musical tones. The first three bits (D0-D2) of the 8-bit code hold the tone values as numbers between 0 and 7, representing notes A-G. Bit D3 indicates whether the note is a natural tone or a sharp. Bits D4-D6 provide information on how close the monitored frequency is to the precise frequency for a given note. Bit D6 indicates whether the monitored tone is above or below the optimum tuning pitch.

Outputs D0-D2 and D4-D6 are routed to inputs A0-A2 of the two latching multiplexers IC9 and IC11, providing the respective address codes which control their output lines. At the end of each one second counting period, pins 4 of IC9 and IC11 receive a negative-going pulse from IC4 pin 7 which transfers the data on the address inputs to an internal register. The address sets the corresponding output line high, providing current to a monitoring LED. LED7-LED13 monitor the note value lines and LED14-LED21 display the tuning accuracy value. Simultaneously, bits D4 and D7 are latched into the D-type register IC10 whose Q0 and Q1 outputs control LED22 and LED23. IC10's latching is triggered by the positive-going pulse on its pin 9 as supplied from IC4 pin 6.

Relative octave values are not directly set by memory output codes. Instead they are produced via a counter which responds to the transitions from note G to note A during IC7's count sequence. Memory bits D1 and D2 are NANDed by IC1b. When both lines are high, as they are for codes 6 and 7, IC1b pin 8 is set low. When the code changes from 7 to 0, IC1b pin 8 goes high, providing a clock pulse to the second 4-stage counter within IC3 (IC3b) whose QB0-QB2 outputs are fed as the address inputs to the multiplexing latch IC6. Latched by the same control pulse as IC9 and IC11, IC6 controls LED1-LED6 which display the corresponding octave count value. R12 and C3 are included to fractionally extend the clock pulse seen by IC3b's clock input.

At the end of each latch command, IC4 generates a pulse which resets IC7 and IC3b whereupon the signal input pulse counting sequence restarts. Since the LEDs are powered via the latching registers, they retain their display status until the next latching pulse is received.

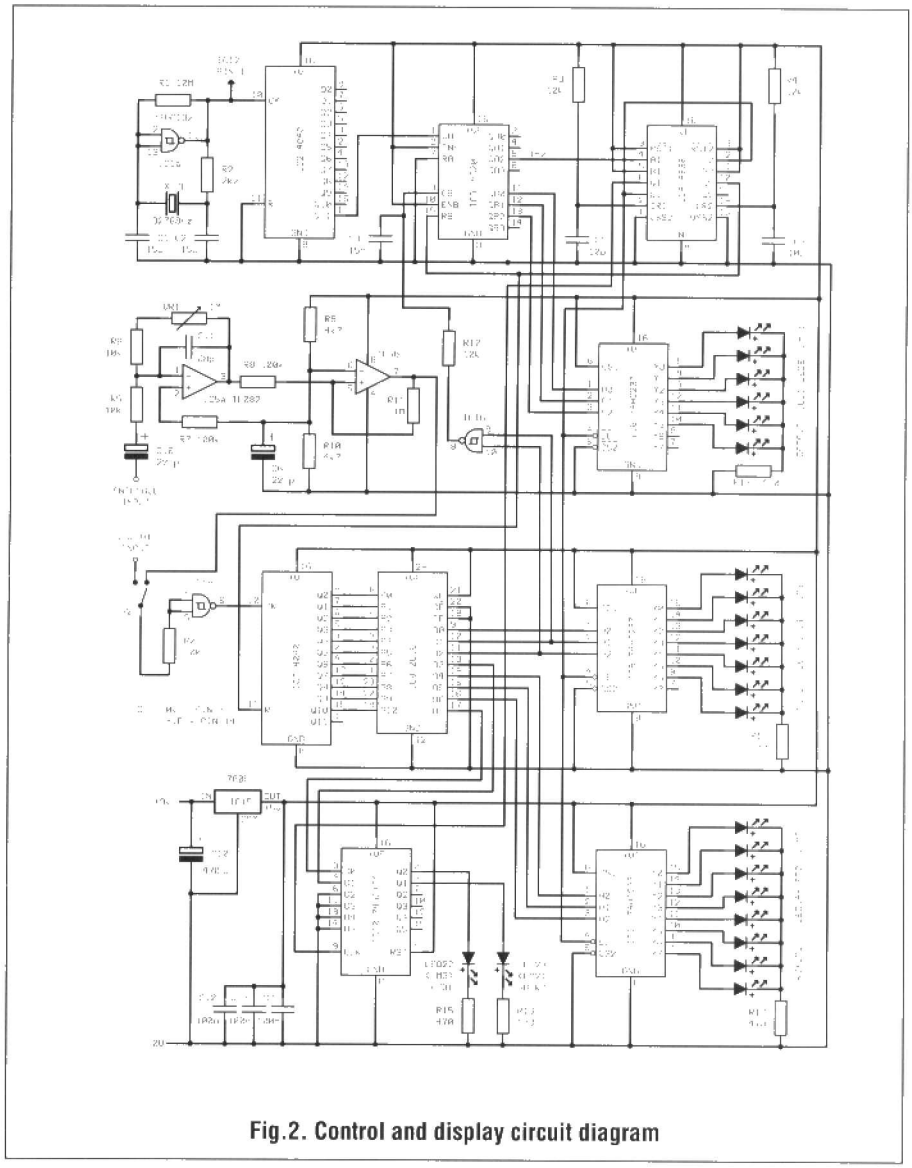


Fig.2. Control and display circuit diagram

Reference Tone

The circuit for the optional reference tone generator is shown in Fig.3. It is not necessary to build this part in order to use the main display facilities but, as most musicians will know, it is useful to also have an audio reference frequency when tuning instruments. Ideally, the reference tone should have been produced using a separate crystal controlled oscillator which would allow for the signal to be set at precisely 440Hz (Concert A). However, to keep this unit simple, it was decided to sub-divide the existing 32768Hz master frequency and to accept a slight compromise on the reference tone precision.

In order to obtain 440Hz from a 32768Hz master frequency a divisor of 74.4727273 is required. However, a digital unit can only divide by integers, consequently the frequencies nearest to 440Hz obtainable

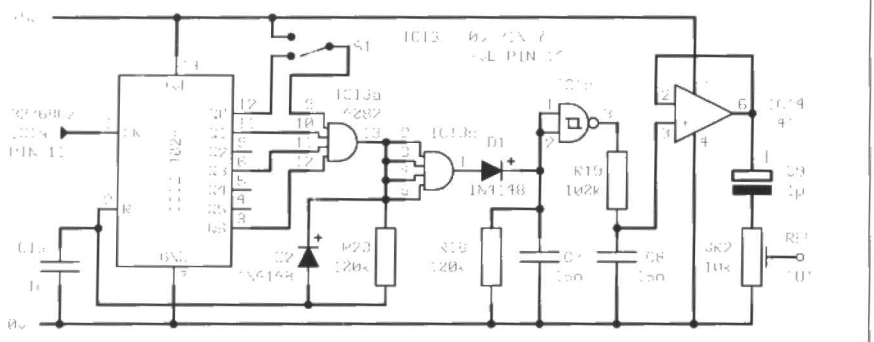


Fig.3. Reference tone generator circuit

from 32768Hz are 442.8Hz and 436.9Hz, dividing by 74 and 75 respectively. Both frequencies have been made available from the reference generator shown in Fig.3, using S1 to switch between them. When using the reference output to assist in the aural tuning of an instrument to 440Hz, S1 should be switched back and forth until the beat frequency between the references and the instrument are similar. If one beat frequency is significantly faster than the other, the instrument is not tuned between the two references.

The 32768Hz clock signal is brought into the 7-stage binary ripple counter IC12. The outputs corresponding to the logic one states of the binary codes for decimal 74 or 75, as partially selected by S1, are ANDed by IC13a which resets IC12 when the correct binary combination prevails. The reset pulse length is fractionally extended by the inclusion of C15, D2 and R20 to allow the buffering AND gate IC13b to also respond reliably to the pulse. From IC13b, the pulse is further extended by D1, R10 and C7 resulting in an output from the Schmitt inverter IC1d which closely approximates a square wave. R19 and C8 smooth the output to a rough triangular shape which is softer on the ear when fed via the buffering opamp IC14 and level setting preset VR2 to the user's own audio amplifier.

```
100 REM TUNING FORK PROG322 04JUN91
110 DIMN(11),A(2047):R=0:N2=16
120 DATA2,10,3,11,4,5,13,6,14,0,8,1
130 FORB=0TO11:READN(B):NEXT
140 DV=LOG(2)/12:FORF=1TO20:IFEXP(DV*F)<1.71875THEN-
NEXT
150 X=LOG(1.71875)-(DV*(F-1))
160 FF=54:FORF=0TOFF-1:A(F)=0:NEXT
170 FORF=FFTO2047:L=LOG(F)/DV:K=INT(L/12)*12;W=(L-
K)*16+14
180 N=INT(W-2)/16-1:IFN-INT(N)>=.5THENN=N+1
190 N=INT(N):V=(K+N)*DV+X:S=EXP(V):IFN>11THENN=N-12
200 F=INT((F+.0051)*100)/100:S=INT((S+.0051)*100)/100
210 A(F)=N(N):IFF<>INT(S)THEN280
220 IFY=0THENJ=F:GOTO350
230 AA=1:BB=7:IFF-Y>BBTHENAA=BB/(F-Y)
240 FORJ-FTOYSTEP-1
250 MS=A(J)AND15:MT=INT(BB+.5):A(J)=MS+(16*MT) 260
PRINT"#"J;MS;MT,A(J):BB=BB-AA:IFBB<0THENBB=0 270
NEXT:J=F
280 IFN=N2THEN350
290 IFJ=0THENY=F:GOTO350
300 AA=1:BB=7:IFF-J>BBTHENAA=BB/(F-J)
310 FORY=JTOF
320 MS=A(Y)AND15:MT=INT(BB+.5):A(Y)=MS+(16*MT)+128 330
PRINT"*"Y;MS;MT,A(Y):BB=BB-AA:IFBB<0THENBB=0 340
NEXT:Y=F:N2=N
350 NEXT
360 REM DECIMAL TO HEX
370 W$="123456789ABCDEF"
380 FORB=0TO2047:IFB/8=INT(B/8)THENN=B:H=3:
PRINT:GOSUB400 390 H=1:N=A(B):GOSUB400:NEXT:PRINT:
PRINT"FINISHED":STOP
400 FORT=HTOOSTEP-1:A=16^T:REM 16 TO POWER OF T
410 IFN/A>=1THENW=INT(N/A):PRINTMID$(W$,W,1);:N=N-
W*A:GOTO430 420 PRINT"0";
430 NEXT:PRINT" ";:RETURN
```

Software

Either an EEPROM or an EPROM with identical pinout functions may be used to hold the look-up table. Constructors must have access to a suitable programmer in order to load the chip with its data. The data codes should be calculated on a computer programmed with a suitable variant of the Basic software listing in Fig.4. The listing was written on a Commodore 3032 computer but is readily translatable for other machines. For constructors without a computer, a hex dump listing is available from the PE Editorial office at a charge of £2.

Full discussion of the software is beyond the scope of this article although the following points are pertinent to a basic understanding:

The frequency of musical octaves increases at a logarithmic rate, each octave having twice the frequency of the preceding one. Taking Concert A as 440Hz, note 'A' of the immediate octaves to either side has frequencies of 55Hz, 110Hz, 220Hz, 880Hz, 1760Hz, 3520Hz. The notes within each octave also increase in frequency by equal logarithmic steps. In essence, the software takes in turn each integer frequency between 54Hz and 2047Hz (the maximum memory size) and calculates its relationship to the ideal frequency of the nearest tone within a twelve tone scale. Numerical values are allocated to represent the natural notes A to G and a further bit is set to indicate a sharp. Although it is accepted that some musical purists may disagree with the notation, the twelve tone

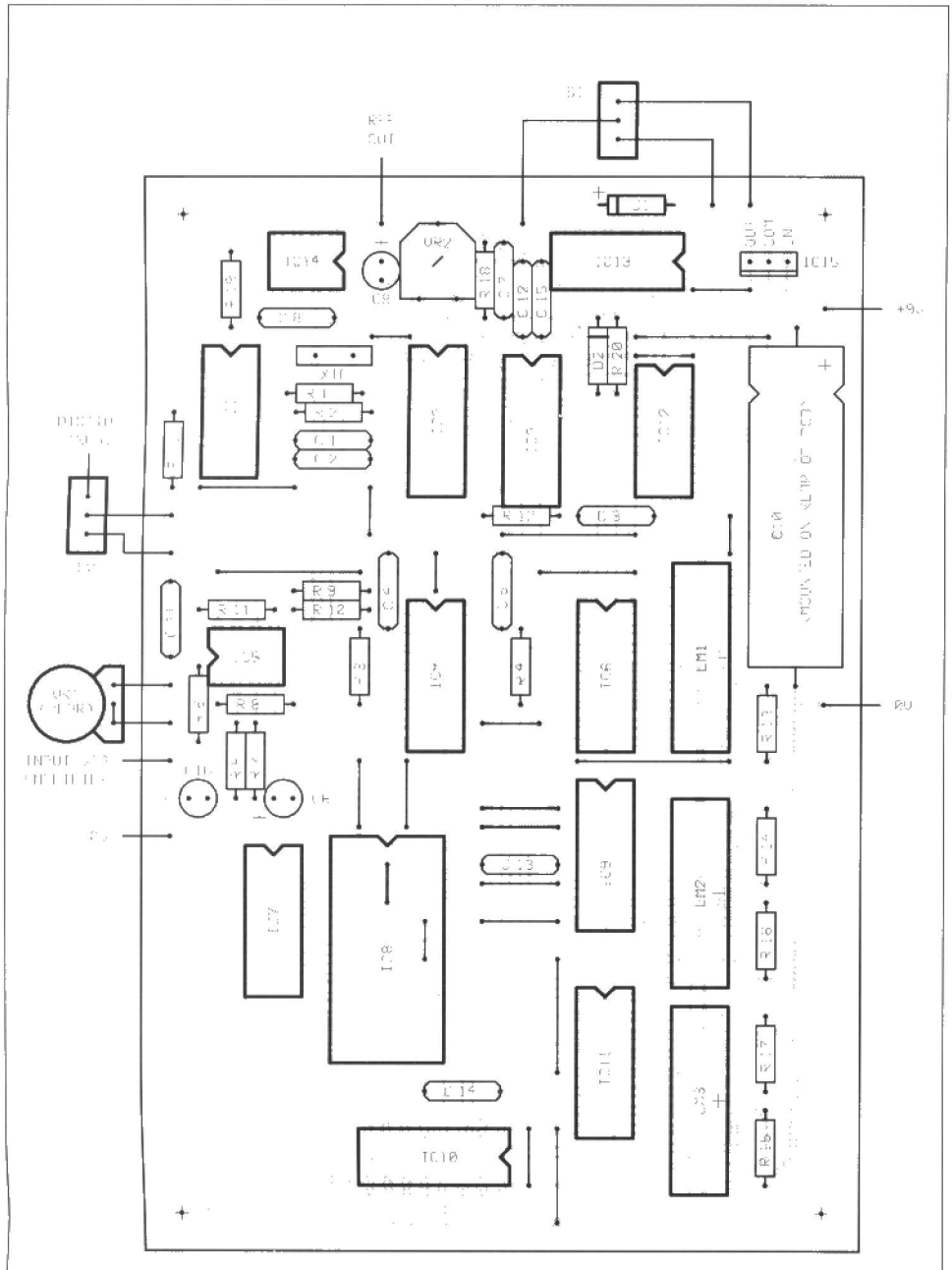


Fig.5. Printed circuit board component layout

scale has been taken as A, A#, B, C, C#, D, D#, E, F, F#, G, G#, A. Program line 120 gives the numerical values allocated to represent the 11 different notations, commencing with note C.

Lines 140 and 150 take 1.71875Hz (the frequency of the first sub-octave of note A above 1Hz) as a base from which a logarithmic value for an interval of one twelfth of a tone is calculated. During the subsequent looped processing, each time the loop integer is found to be the value closest to the ideal frequency for a tone, the frequency interval between this tone and the previous one is split into eight integer subdivisions which are retrospectively ANDed with earlier note data values stored in array variable A( ). Additional subroutines AND further data relating to whether the frequency is above or below the ideal. The print statements in lines 260 and 330 provide screen information on the progress of the main loop subroutines. On completion of the full calculation routine, the stored decimal data is coded into the hexadecimal (hex) format usually required by E(E)prom programmers, printing the data to screen. Users should include additional commands in this routine to send the data to printer or disc.

Before running the program in its entirety, check that the following results (or close to them) are produced by the computer:

Log(2) = 0.693147181
DV = 0.057762265
X = 0.0217368971
EXP(2) = 7.3890561

(DV and X may be displayed as 5.776226E-02 and 2.173692E-02.)

In the hex dump, addresses 0000 to 002A all hold zeros (00), then the next four lines should read:

0030 00 00 00 00 00 00 60 F0
0038 E0 68 F8 E8 61 F1 E1 D1
0040 62 F2 E2 5A 6A FA EA 53
0048 63 F3 E3 D3 6B FB EB DB

As a further programming guide, the following is a list of calculated frequencies in Hertz for the designated notes in the octave commencing with Concert A:

A 440.0
A# 466.163762
B 493.883302
C 523.251131
C# 554.365263
D 587.329536
D# 622.253968
E 659.255115
F 698.456464
F# 739.988846
G 783.990873
G# 830.609396
A 880.0

Tuning Up

The circuit has been designed to run from a 9V DC supply, such as a 9V battery eliminator (mains adaptor) regulated down to 5V by IC15.

Fig.5 shows the printed circuit board component layout and Fig.6 shows the tracking details. For compactness, 10-way DIL LED modules were used on the Author's model, ignoring the unused LED positions. Individual LEDs may be used instead if preferred. It is recommended that sockets should be used for all ICs and for the LED modules. Note that two of the link wires on the PCB go below IC8. C10 may be mounted below the PCB allowing the board to be mounted flush with the front panel of a suitable box in which slots are cut for viewing the LEDs.

Thoroughly check all soldered joints at the end of assembly, in particular making sure that solder bridging between close-run pads and tracks has not occurred. Before

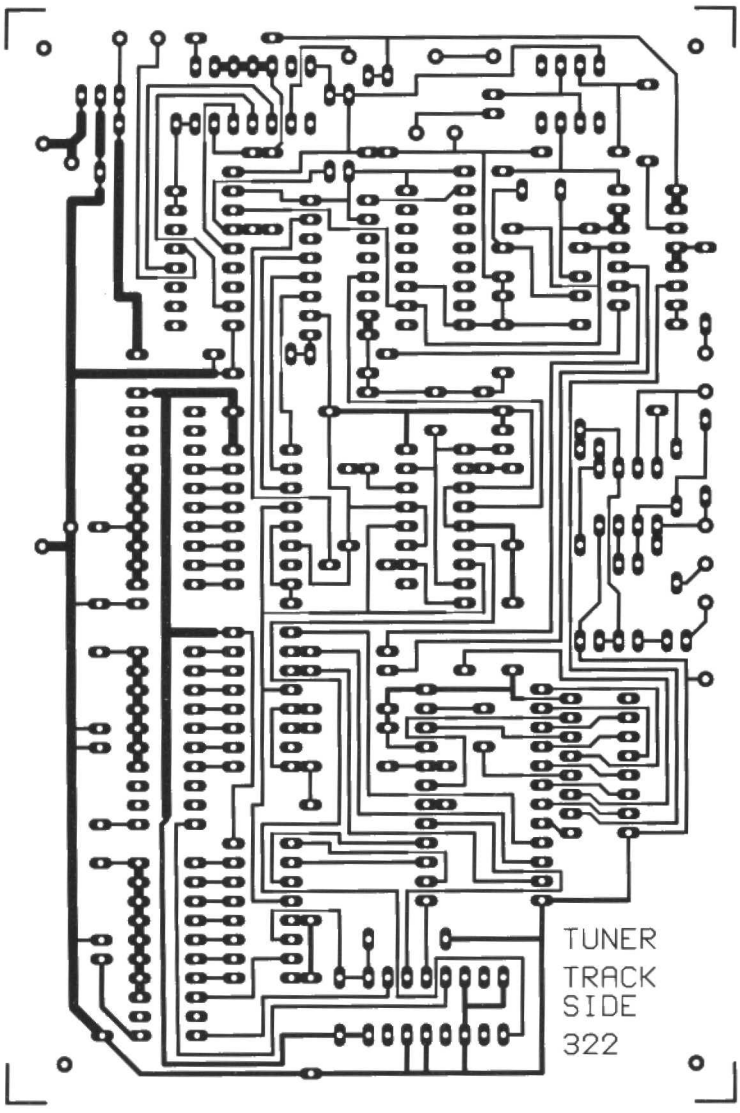


Fig.6. PCB track details

inserting any IC except IC15, check that with power applied to the board the output of IC15 delivers 5V. A voltage significantly below this could indicate a power line short. If the voltage is above 5V it is likely that IC15 is incorrectly inserted.

With all ICs on board, if the circuit fails to work first time switch off and recheck the assembly. No setting-up is required, just couple the unit to a variable frequency signal source, adjust VR1 to suit the input level and observe the LED responses. If the reference tone board has been built it may be used as the initial signal source, and may itself be checked by plugging it into any normal amplifier system.

A voltmeter can be used to check that a 1Hz signal is being produced at the output of IC3 pin 5. The meter can also be used to check the status of the later outputs of IC7 and of the memory outputs when an input signal is being fed in to the preamp. Should none of the LEDs appear to function, check that they are correctly oriented in their sockets.

When tuning an instrument, its note duration and amplitude should be sufficiently great to allow the tuner time to respond to several sampling cycles. The optimum tuning accuracy will be indicated by LED22 alternating fairly uniformly between on and off. ■

Components

Resistors

R1	10M
R2	2k2
R3-R6, R12, R21	10k
R7, R8, R18-R20	100k
R9, R10	4k7
R11	1M
R13-R17	470R

All 0.25W 5% or better

Capacitors

C1, C2	15p polystyrene
C3, C7, C8	15n polyester
C4, C5	10p polystyrene
C6, C16	22µu 16V electrolytic
C9	1µ 16V electrolytic
C10	470µ 16V electrolytic
C11	68p polystyrene
C12-C14	100n polyester
C15	1n polystyrene

Semiconductors

D1, D2	1N4148
IC1	74HC132
IC2, IC7	4040
IC3	4520
IC4	4538
IC5	TL082
IC6, IC9, IC11	74HC237
IC8	2816 EEPROM (see text)
IC10	74HC174
IC12	4024
IC13	4082
IC14	741
IC15	7805
LM1-LM3	10-way DIL LED modules

Potentiometers

VR1	1M lin rotary
VR2	10k min horiz preset

Switches

S1, S2	SPDT min toggle

DIL IC sockets

8-pin x 2, 14-pin x 3, 16-pin x 8, 20-pin x 3, 24-pin

Miscellaneous

32768Hz crystal, printed circuit board, PCB supports x 4, input and output sockets to suit, knob, box to suit.

Constructors note

The Author's semiconductors were purchased from RS/Electromail.

Techniques

Andrew Armstrong explains how to go about turning a project idea into a practical device.

A recent reader's letter to Techniques expressed the reader's dismay that, having written to several electronics suppliers requesting a circuit diagram for an application he wanted to build and a parts list and quotation for the necessary parts, he had received no joy from any of them. The application was of medium complexity and non-standard design.

If our reader had asked for, let us say, a circuit for a simple radio receiver using a standard radio IC, then it is quite likely that Maplin, Cirkit, or somebody else would have been able to locate a standard circuit and maybe have a PCB or complete kit available. Because the reader's requirement was not for a standard application, the supplier would have had to spend a minimum of several man-hours, and maybe several man-days, to design a suitable circuit for this project. He would have to do a thorough job, because the customer would have the expectation that it would work first time, and would no doubt expect him to make it work if there were any design errors.

Indeed, to design this particular application for industrial manufacture – which, to be fair, is not implied in the reader's request – I would probably have made a charge somewhere in the low thousands of pounds. And this is not expensive. Clearly, this is an overlarge commitment for a components supplier to sell a few tens of pounds'-worth of parts!

Design Stages

How does one go about producing a design, whether as a magazine project or as a product to be manufactured?

To avoid giving away any current trade secrets, I will use as an example something which I designed some years ago.

This started with a friend who was tired of his car windscreen-wipers scraping the glass in conditions of light drizzle (this was before the days when car manufacturers had developed the type of windscreen wiper which scrapes the glass even in conditions of heavy rain) asked me if it was possible to design an intermittent wiper which would accommodate itself to the weather conditions, rather than only being suitable for a narrow range of precipitation. I suggested a variable delay unit, but he didn't want to drill extra holes in his dashboard. No problem, said I, confidently. I can design a variable windscreen wiper delay unit which does not need any extra controls to be fitted to your car.

The method I chose was to detect operations of the windscreen wiper switch, to time the interval between two successive operations, and to automatically operate the windscreen wipers with a time delay equal to the measured time period.

The timing was carried out by charging a capacitor via a large resistor, after the first switch operation, and switching off the charge current using a bipolar transistor after the second switch operation. A relaxation oscillator using the same RC time constant was then used to control the wipers, with the charging switching point of the timer set by the stored charge on the first capacitor. I had been concerned about charge leakage, but the data book showed that the leakage through the transistor used to switch off the charging current was low enough not to change the timing by a significant amount over a period of half an hour. A CMOS op-amp was used as the relaxation oscillator, so that charge leakage through this was also negligible. It only took me half a day to design, and another couple of hours to build a prototype which worked very well.

The next stage was to make several units for several different people's cars. The problems started to appear. What had worked well with the switch and motor on my car failed to respond to the switch operations on my friend's car, because I had applied slightly too much switch-bounce suppression. A reduction of the bounce-suppression to the minimum which would work on my car, caused multiple triggering in a vehicle owned by a third friend, and in the end I had to resort to multiple time-constants to

To design this particular application for industrial manufacture I would probably have made a charge somewhere in the low thousands of pounds.

cope with the range of switch-bounce and parking contact delay across a range of vehicles. The experimenting with, and correction of, the switch-bounce circuitry, took longer than the initial design.

Still, now we had a working product with the bugs carefully removed, so we could manufacture a number to sell.

The Veroboard prototypes were clearly unacceptable for sale, so we searched for a suitable box for which we could design a printed circuit. Because the unit would be housed under the bonnet and could be subjected to road spray it had to be sealed, and we found no suitable sealed case at a reasonable price. This was not seen as a problem and decided to use a good-quality potting compound intended for electronic products. We had a metal mould fabricated, designed the PCBs to fit, and made and potted some samples. The friend who had originally raised the question tried the first one on his car, and was upset to find that it became unreliable after a few weeks.

Considerable investigation eventually revealed that the potting compound, though properly cured, absorbed moisture from the atmosphere slowly, and eventually became faintly conductive. The conduction was just enough to leak away the charge on a 2.2µF capacitor over a period over about two minutes. We were now faced with the choice of redesigning the circuit to avoid the problem, or redesigning the housing – in which we had already invested effort and money.

An internal plastic cover over the sensitive part of the circuit proved ineffective, because the potting compound would flow in through the smallest gap, and sealed boxes were still quite unattractive, so we decided to modify the circuit.

My first approach was to try to increase the capacitance value far enough that the leakage would not matter, but the only way to do that was to use an electrolytic, and no reasonably-priced electrolytic capacitor was specified to have a low enough internal leakage to hold its charge long enough regardless of any external leakage. In reality, most electrolytic capacitors will do the job when tested, but I wanted to avoid units failing subsequently due to ageing of the components or to temperature variations.

In the end, I re-designed the unit from scratch using digital instead of analogue timing and this solved all the problems

In the end, I re-designed the unit from scratch using digital instead of analogue timing, and this solved all the problems and resulted in a product of which some samples are in service to this day. A cut-down embodiment of this was subsequently published as a magazine project, and the kit is still being marketed by Cirkit.

If the first prototype design had been published as a magazine project, it would not have been good enough: some readers' units would have worked well, because the characteristics matched the windscreen wiper circuity in their cars, and others would not have worked, because of excessive switch bounce or switching delays. Unfortunately, some magazine projects do fall into this category, because it is very difficult to predict all the problems which might arise on use in different situations, and it is normally uneconomic for the developer to make and test half a dozen or more prototypes to improve the design.

The design at the stage when the time constant problems had been solved, but before the unit had been redesigned as a digital circuit, would have been suitable for publication in a magazine, because it is not unreasonable to expect that electronics hobbyists can take care to mount their project away from direct road-spray, and that they could individually seal a plastic case once it has been installed. It is preferable to go one stage better than this for a magazine project, but it is very often not possible.

The third main stage of the design which was an acceptable product for manufacture, had taken a number of man-weeks to develop; a period of time totally out of proportion to the less than one day needed to make the first model work quite acceptably.

In summary, to design a product a good approach is first of all to decide upon the broad means by which the job is to be done, then to sort out the details and try to predict future tolerance problems. Then several prototypes are normally desirable to show any snags which may have been overlooked. After this stage, minor or major redesign may be needed. In extreme cases the whole scheme may need to be changed. Attempts to short circuit this procedure leave a risk of a design which cannot be relied upon to work in all cases. ■

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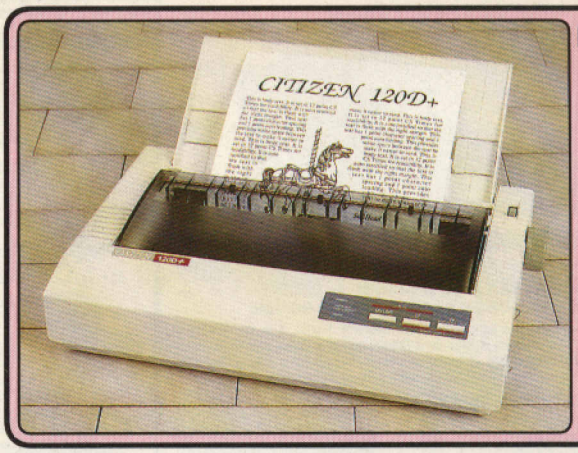

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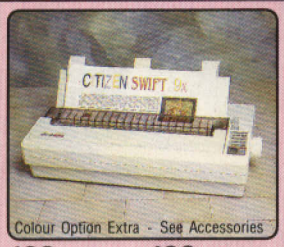

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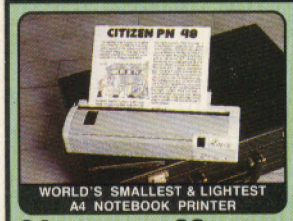

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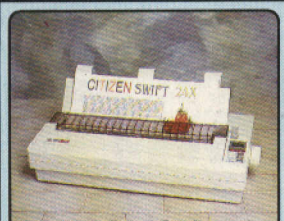

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